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DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

REPORT

OF

PROGRESS OF STREAM MEASUREMENTS

FOR

THE CALENDAR YEAR 1904

PREPARED UNDER THE DIRECTION OF F. H. NEWELL

BY

W. B. CLAPP

PART XI.—The Great Basin and Pacific Ocean Drainage in California.

WASHINGTON
GOVERNMENT PRINTING OFFICE
1905

CONTENTS.

	Page.
Letter of transmittal	7
Introduction	9
Cooperation and acknowledgments	18
Colorado River drainage basin	19
Colorado River at Yuma, Ariz	20
Summary of evaporation record at Yuma, Ariz	26
Imperial canal at California-Mexican boundary line	26
Imperial Valley canals	29
Miscellaneous measurements in Colorado River drainage basin	41
Duty of water and seepage investigations near Yuma, Ariz	42
Southern California drainage	47
Arroyo Seco near Soledad, Cal	48
Santa Ynez River near Santa Barbara, Cal	51
Mono Creek at Mono dam site, Cal	55
Malibu and Triumfo creeks near Calabasas, Cal	58
San Gabriel River and canals near Azusa, Cal	62
San Luis Rey River near Pala, Cal	65
Santa Ana River near Mentone, Cal	67
Santa Maria River near Santa Maria, Cal	70
Mohave River at Victorville, Cal	72
Miscellaneous measurements	74
San Francisco Bay drainage basin	103
Puta Creek near Guenoc, Cal	106
Evaporation record of Clear Lake at Lakeport, Cal	109
Cache Creek at Lower Lake, Cal	109
Cache Creek near Yolo, Cal	113
Stony Creek near Fruto, Cal	116
Sacramento River near Red Bluff, Cal	118
McCloud River near Gregory, Cal	122
West Valley Creek near Likely, Cal	123
Pit River (South Fork) near Ivy, Cal	125
Pit River near Canby, Cal	128
Ash Creek at Adin, Cal	132
Pit River near Bieber, Cal	134
Feather River at Oroville, Cal	137
Yuba River near Smartsville, Cal	140
Bear River above Wheatland, Cal	144
American River near Fairoaks, Cal	145
Sacramento River at Sacramento, Cal	145
Mokelumne River at Electra, Cal	148
Mokelumne River near Clements, Cal	150
Stanislaus River at Knights Ferry, Cal	151
Stanislaus Water Company's ditch at Knights Ferry, Cal	154

San Francisco Bay drainage basin—Continued. Page.
Tuolumne River at Lagrange, Cal 156
Turlock canal at Lagrange, Cal 159
Modesto canal at Lagrange, Cal 161
Merced River above Merced Falls, Cal 163
San Joaquin River at Herndon, Cal 165
King River near Sanger, Cal 167
King River at Kingsburg, Cal 169
Kaweah River below Three Rivers, Cal 170
Tule River near Porterville, Cal 173
Kern River near Bakersfield, Cal 176
Stations in Yosemite Valley, California 177
Merced River near Sentinel Hotel, at Yosemite Valley, California 178
Tenaya Creek at Yosemite Valley, California 179
Yosemite Creek at Yosemite Valley, California 180
Miscellaneous measurements 181
Northern Pacific Ocean drainage basin 188
Lost River at Clear Lake, Cal 188
Miller Creek near Lorella, Oreg 189
Lost River at Merrill, Oreg 190
Klamath River at Keno, Oreg 190
Klamath River at Klamath Falls, Oreg 191
Sprague River at Yainax, Oreg 193
Upper Klamath Lake near Pelican, Oreg 193
Tule Lake near Merrill, Oreg 194
Miscellaneous measurements in Klamath River drainage basin 194
Miscellaneous measurements in Northern Pacific Ocean drainage basin 195
The Great Basin drainage 196
Susan River near Susanville, Cal 197
Willow Creek at Merrillville, Cal 199
Owens River near Round Valley, Cal 200
Rock Creek near Round Valley, Cal 204
Pine Creek near Round Valley, Cal 207
Owens River canal near Bishop, Cal 211
Bishop Creek canal near Bishop, Cal 214
Farmers' canal near Bishop, Cal 216
McNally canal near Bishop, Cal 219
George Collins's canal near Bishop, Cal 222
Bishop Creek near Bishop, Cal 225
Rawson canal near Bishop, Cal 229
A. O. Collins's canal near Bishop, Cal 232
Dell canal near Bishop, Cal 235
Big Pine and Owens River canal near Bishop, Cal 238
Sanger canal at Alvord, Cal 240
East Side canal near Citrus, Cal 242
Stevens canal near Citrus, Cal 245
Owens River near Citrus, Cal 248
Powers canal near Bishop, Cal 251
South Hillside canal near Bishop, Cal 253
North Hillside canal near Bishop, Cal 255
Big Pine Creek near Big Pine, Cal 257
Miscellaneous measurements 259
Index 263

ILLUSTRATIONS.

		Page.
PLATE	I. Map showing location of principal gaging stations in the United States	10
	II. Price current meters, with buzzers	11
FIG.	1. Cable station, showing section of the river, car, gage, etc	11

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
HYDROGRAPHIC BRANCH,
Washington, D. C., April 15, 1905.

SIR: I transmit herewith the manuscript of Part XI of a series of twelve papers which compose the Report of Progress of Stream Measurements for the Calendar Year 1904. Parts I to VI of this report contain the results of the data collected in the territory east of Mississippi River. Parts VII to XII are devoted to the data collected in the territory west of Mississippi River.

The original data for this report were collected in cooperation with the State of California under the direction of J. B. Lippincott, supervising engineer for that State. The field operations were under the immediate direction of W. B. Clapp. The assembling of the data and their preparation for publication were done under the direction of Mr. Clapp. The original manuscript contained all the data collected in California during 1903 and 1904. As the 1903 data were published in Water-Supply Paper No. 100, they have, with a few exceptions, been omitted from this report.

I request that this manuscript be published as one of the series of Water-Supply and Irrigation Papers.

Very respectfully,

F. H. NEWELL,
Chief Engineer.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

PROGRESS REPORT OF STREAM MEASUREMENTS FOR THE CALENDAR YEAR 1904.

PART XI.

By W. B. Clapp.

INTRODUCTION.

The hydrographic work of the United States Geological Survey includes the collection of facts concerning and the study of conditions affecting the behavior of water from the time it reaches the earth as rain or snow until it joins the oceans or great navigable rivers. These investigations became a distinct feature of the work of the Survey in the fall of 1888, when an instruction camp was established at Embudo, N. Mex. Since that date the work has been continually and gradually extended as larger funds became available. The first distinctive appropriation for gaging streams was made by the act of August 18, 1894, which contained an item of $12,500, "for gaging the streams and determining the water supply of the United States, including the investigation of underground currents and artesian wells in the arid and semiarid sections." (Digest of Appropriations for 1895, p. 270.)

Since that time a similar act has been passed each year and the appropriations have gradually increased, as shown in the following table:

Annual appropriations for hydrographic surveys.

Year ending June 30, 1895	$12,500
Year ending June 30, 1896	25,000
Year ending June 30, 1897	50,000
Year ending June 30, 1898	50,000
Year ending June 30, 1899	50,000
Year ending June 30, 1900	50,000
Year ending June 30, 1901	100,000
Year ending June 30, 1902	100,000
Year ending June 30, 1903	200,000
Year ending June 30, 1904	200,000
Year ending June 30, 1905	200,000
Year ending June 30, 1906	200,000

The chief feature of the work of the hydrographic division is the systematic study of the flow of the surface waters and the conditions affecting the same. In this connection other information that may be of use to the engineer or others in hydrographic studies, such as river profiles, duration and extent of damage by floods, water-power data, etc., is collected. Furthermore, the work has been so directed that the information collected will be of direct value in the commercial and agricultural development of the country.

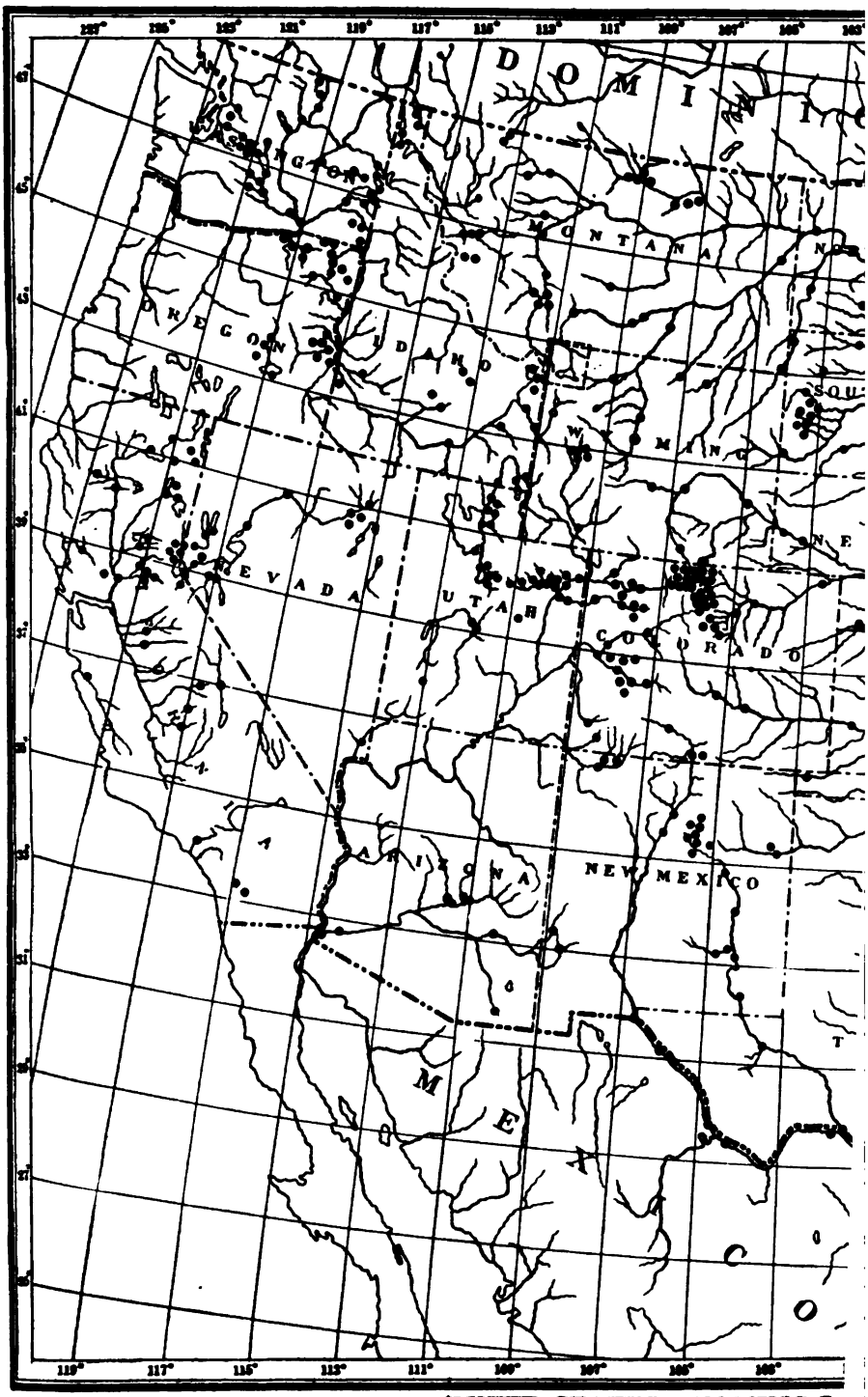
As a result of the increased appropriations since June 30, 1902, the work has been largely extended and thoroughly systemized. The various States have been grouped into districts, each of which is under the supervision of a district hydrographer who, with a corps of assistants, devotes his whole time to the study of the hydrographic resources of his district.

The methods used in the collection of these data and in their preparation for publication are given in detail in Water-Supply Paper No. 94. (Hydrographic Manual, U. S. Geol. Survey.)

The general plan of stream gaging which has been developed is to obtain eventually data in regard to the flow of all the important streams in the United States. With this in view gaging stations are established at points where the data will be of greatest commercial value. At these stations discharge measurements are taken from time to time at typical river stages, and the daily surface fluctuation is obtained by means of gage readings. From these two factors it is possible to estimate both the total flow and its distribution through the period of observation.

The selection of the site for a gaging station and the length of time the station is maintained depend largely upon the needs of each locality. If the stream is to be used for water power, special efforts are made to obtain information concerning the low-water flow. If water is to be stored, the high waters are given special attention. In all sections certain permanent stations are maintained for general statistical purposes to show the conditions which exist through long periods. They also act as primary stations, and are used in connection with short series of measurements to determine the flow in particular portions of the drainage basin.

Gaging stations are divided into two general classes: First, current-meter stations, and, second, weir stations. The former class is subdivided as to location into bridge, cable, boat, and wading stations. Fig. 1 shows a cable station with car, tag line, inclined gage, etc. In addition to the bridge, cable, or boat, the equipment of a current-meter gaging station consists in a gage for determining the daily fluctuations of the water surface, bench marks to which the zero of the gage is referred, and permanent marks on the bridge or a tagged line indicating the points of measurement. Where the current is swift



MAP OF THE UNITED STATES, SHOWING L

PRICE CURRENT METERS, WITH BUZZERS.

some appliance, generally a secondary cable, is necessary to hold the meter below the surface.

Gaging stations are generally located at bridges, if the channel conditions are satisfactory, as from them the meter can be easily manipulated, and the cost of the equipment is comparatively small. The stations are located as far as possible at points where the channel is straight, both above and below the gaging section, and where there are no cross currents, backwater, or boils. The bed of the stream should be as clear as possible from large projections and of a permanent character. The banks should be high, and should overflow at high stages only. At stations with shifting beds more measurements are made, and special methods of computing daily discharges are employed. Great care is taken in the selection and equipment of gaging stations in order that the data may have the required degree of accuracy.

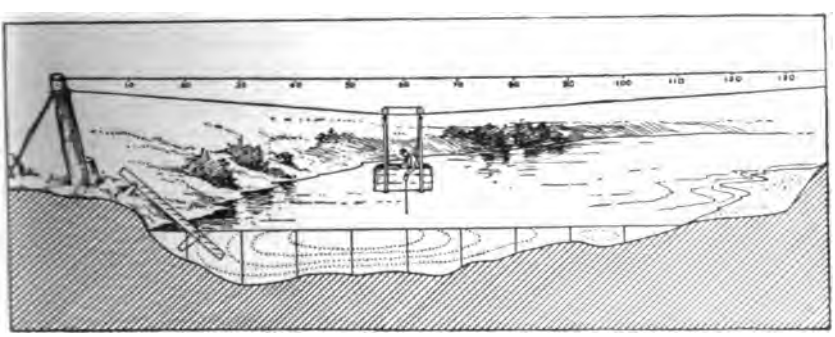


FIG. 1.—Cable station, showing section of river, car, gage, etc.

On many of the larger rivers, where water power is developed by dams, estimates of flow are obtained by observing the head on the crest and using a weir formula. On the smaller streams sharp-crested weirs are in some cases erected.

The principal instrument used in stream-measurement work is the current meter, by which the velocity of the flow of water is determined. After years of experience the Survey has adopted the Price current meter for general work. This meter, as is shown on Pl. II, is made in two sizes, known as the large and small Price. The small Price has been largely developed by the officers of the Survey, using the Price acoustic meter as a basis.

A discharge measurement is the determination of the quantity of water flowing past a certain point at a given time. This quantity is the product of two factors: (1) The mean velocity, which is the function of the cross section, surface slope, wetted perimeter, and roughness of bed; (2) the area, which depends upon the permanency of the bed and the fluctuations of the surface, which govern the depth.

In making the measurement an arbitrary number of points are laid off perpendicular to the thread of the stream (see fig. 1). These points are usually at regular intervals varying from 2 to 20 feet, depending upon the size and conditions of the stream. They are known as measuring points, and at them the observed data, the velocities and soundings, are taken. The perpendiculars dropped from the measuring points divide the gaging section into strips, and for each strip or pair of strips the mean velocity, area, and discharge are determined independently; thus conditions existing in one part of the stream are not distributed to parts where they do not apply.

The methods of obtaining velocity with the current meters which are in general use may be grouped into three classes: Single point, multiple point, and integration.

The single-point method consists in holding the meter either at the depth of the thread of mean velocity, or at an arbitrary depth for which the coefficient for reducing to mean velocity has been determined. Extensive experiments by vertical velocity-curves show that the thread of mean velocity lies at from 0.5 to 0.7 of the total depth. In general practice the thread of mean velocity is considered to be at 0.6 depth, and it is at this depth that the meter is held in the majority of the measurements, this being known as the six-tenth depth method. It is found by a large number of vertical velocity-curve measurements, taken on various streams and under various conditions, that the coefficient for reducing the velocity obtained at six-tenths depth to mean velocity is practically unity, ranging, in a series of 910 measurements made at 39 gaging stations, between .94 and 1.04, with a mean for the 910 observations of 1.00. In the other principal single-point method the meter is held near the surface, usually 1 foot below, or low enough to be out of the action of the wind or other disturbing influences. This is known as the subsurface method. The coefficient for reducing the velocities taken at the subsurface has been found by repeated experiments with vertical velocity-curves to be from .85 to .95, depending upon the depth of the stream and velocity and channel conditions. This method is specially adapted for flood measurements, or when the velocity is so great that the meter can not be kept at 0.6 depth.

The three principal multiple-point methods in general use are: The vertical velocity-curve; top and bottom; and top, bottom, and mid depth. In the vertical velocity-curve method a series of velocity determinations are taken in the vertical at regular intervals, usually from 0.5 to 1 foot apart. By platting these velocities as abscissas and their depths as ordinates, and drawing a smooth curve through these points, the vertical velocity-curve is produced, which shows the change in velocity from the surface to the bottom of the stream. The mean velocity in the vertical is then obtained by dividing the depth

into the area bounded by this mean velocity-curve and the initial line. Owing to the length of time it takes to make these measurements they are seldom used except for determining coefficients for purposes of comparison and for measurements under ice.

In the second multiple-point method the meter is held from 0.5 to 1 foot below the surface and about 0.5 foot above the bottom, and the mean of the velocities at these two points is taken as the mean velocity for that vertical. This method is not well adapted for general work, as the roughness of the bottom disturbs the velocity at that point. For shallow streams with comparatively smooth beds good results are obtained by this method. In the third multiple-point method the meter is held at mid depth, 0.5 foot below the surface, and 0.5 foot above the bottom, and the mean velocity is determined by dividing the sum of the top velocity, twice the mid-depth velocity, and the bottom velocity by 4.

The vertical-integration method consists in moving the meter at a slow, uniform speed from the surface to the bottom and back again to the surface. The number of revolutions and the time taken in the operation is noted, and the mean velocity is found by dividing the number of revolutions by the number of seconds taken in the run. This method has the advantage, in that the velocity at each point of the vertical is measured twice. It is well adapted for measurements under ice and as a check on the point methods.

The area, which is the other factor for determining the discharge of the stream, depends upon the stage of the river, which is taken on a gage, and the general contour of the bed of the stream, which is found by sounding. The soundings are usually taken at each measuring point at the time of the discharge measurement, either by using the meter and cable or by a special sounding line or rod. For stations with permanent beds standard cross sections are usually taken during low water. These sections serve to check the soundings which are taken at the time of the measurements, and from them any change which may have taken place in the bed of the stream can be detected. They are also used for obtaining the area for use in high-water measurement computations, as accurate soundings are hard to obtain at high stages.

In computing the discharge measurements from the observed velocities and depths at the various points of measurements the measuring section is divided into elementary strips, as shown in fig. 1, and the mean velocity, area, and discharge are determined separately for either a single or double strip. The total discharge and area are the sums of those for the various strips, and the mean velocity is obtained by dividing the total discharge by the total area.

The volume of water flowing in a stream is known as run-off. In expressing it various units are used, depending upon the kind of work for which the data are needed. Those used in this report are "second-

feet," "acre-feet," "run-off per square mile," and "run-off in depth in inches," and may be defined as follows:

"Second-foot" is an abbreviation for cubic foot per second, and is the body of water flowing in a stream 1 foot wide, 1 foot deep, at a rate of 1 foot per second.

The "acre-foot" is the unit of capacity used in connection with storage for irrigation work, and is equivalent to 43,560 cubic feet. It is the quantity required to cover an acre to a depth of 1 foot. There is a convenient relation between the second-foot and the acre-foot; 1 second-foot flowing for twenty-four hours will deliver 86,400 cubic feet, which equals 1.9835 acre-feet, or, approximately, 2 acre-feet.

The expression "second-feet per square mile" means the average number of cubic feet of water flowing each second from every square mile of drainage area on the assumption that the run-off is uniformly distributed.

"Depth in inches" means the depth of water in inches that would have covered the drainage area, uniformly distributed, if all the water could have accumulated on the surface. This quantity is used for comparing run-off with rainfall, which quantity is usually given in depth in inches.

It should be noticed that "acre-feet" and "depth in inches" represent the actual quantities of water which are produced during the periods in question, while "second-feet," on the contrary, is merely a rate of flow per second.

The base data for computing the daily discharge of a stream are the daily gage heights and the various discharge measurements, of which there should be sufficient number to cover the range of stage. The fundamental laws upon which these computations are based are the following:

(1) The discharge will remain constant so long as the conditions at or near the gaging station remain constant;

(2) Neglecting the change of slope due to the rise and fall of the stream, the discharge will be the same whenever the stream is at a given stage; and

(3) The discharge is both a function of, and increases gradually with, the gage heights. (2 and 3 depend on 1.)

As the beds of many streams are changeable, the problem divides itself into two classes: (1) Those of streams with permanent, or practically permanent, beds, and (2) those of streams with changeable beds. The base data and methods of obtaining them are the same for either class, and it is only in the computation of the mean daily flow that different methods are necessary.

In determining the daily discharge of streams with permanent beds the results of the discharge measurements are plotted on cross-section paper, with gage heights as ordinates and discharges as abscissas.

Through these points a smooth curve is drawn, which shows the discharge for any gage height, and from which a rating table is prepared. Aside from plotting the discharge, the mean velocity and area determined for each discharge measurement are plotted. Through these points the curves of mean velocity and of area are drawn, and the rating curve is largely determined by taking the product of the mean velocity and the area at various stages as determined by these curves. These curves of mean velocity and area are of special value to determine the location of the rating curve for stages at which actual discharge measurements are not available and for extending the discharge curve outside the limits of the measurements. In the preparation of the rating table the discharge for each tenth or half tenth on the gage is found from the curve. The first and second differences of these discharges are then taken and adjusted according to the law that they shall either be constant or increasing, never decreasing. The discharges in the table are then changed in accordance with these adjusted differences. In making up the station-rating curve the individual discharge measurements and the conditions under which they were taken are carefully studied in order that proper weight shall be given to each measurement. Rating curves in general take the form of a parabola, and as a rule the high-water portion of the curve approaches a straight line. For stations of permanent character the results of the measurements from year to year should be within 5 per cent of the curve, with the exception of those taken during high water, when the probable error may be as high as 10 per cent.

The determination of the daily discharge of streams with changeable beds is difficult, and unless frequent discharge measurements are made the results obtained are only roughly approximate. For streams with continually shifting beds, such as Colorado River and the Rio Grande, discharge measurements are made every two or three days, and the discharges for the intervening days are obtained by interpolation, modified by the gage heights for these days. For stations with beds which shift slowly, or are only materially changed during floods, station-rating curves and tables can be prepared for the periods between changes, and satisfactory results can be obtained with two or three measurements a month, providing measurements are taken soon after the changes take place.

In determining the flow for periods when the streams are frozen, special rating curves and tables have to be prepared from measurements taken under these conditions. The methods of constructing these curves and tables are the same as for open sections. The discharge measurements, however, are either taken by integration in verticals or by the vertical velocity-curve method, as sufficient experiments have not been made on ice-covered streams to determine the laws which govern the position of the thread of mean velocity.

The Report of Progress of Stream Measurements for the Calendar Year 1904, of which this is Part XI, is published in a series of twelve Water-Supply Papers, Nos. 124–135, inclusive, under the following subtitles:

Part 1. Atlantic coast of New England drainage.
Part 2. Hudson, Passaic, Raritan, and Delaware River drainages.
Part 3. Susquehanna, Patapsco, Potomac, James, Roanoke, Cape Fear, and Yadkin River drainages.
Part 4. Santee, Savannah, Ogeechee, Altamaha Rivers, and Eastern Gulf of Mexico drainages.
Part 5. Eastern Mississippi River drainage.
Part 6. Great Lakes and St. Lawrence River drainage.
Part 7. Hudson Bay, Minnesota, Wapsipinicon, Iowa, Des Moines, and Missouri River drainages.
Part 8. Platte, Kansas, Meramec, Arkansas, and Red River drainages.
Part 9. Western Gulf of Mexico drainage.
Part 10. Colorado River and the Great Basin drainage.
Part 11. The Great Basin and Pacific Ocean drainages in California.
Part 12. Columbia River and Puget Sound drainage.

The territory covered by each paper is given in the subtitle, and the larger drainages are, for convenience in arrangement, subdivided into smaller ones, under which the data are arranged, as far as practicable, geographically.

These papers contain the data that have been collected at the regular gaging stations, the results of the computations based upon the observations, and such other information that has been collected that has a direct bearing on these data including, as far as practicable, descriptions of the drainage areas and the streams draining them.

For each regular station are given, as far as available, the following data:

1. Description of station.
2. List of discharge measurements.
3. Gage-height table.
4. Rating table.
5. Table of estimated monthly and yearly discharges and run-off.

The descriptions of stations give, as far as possible, such general facts about the locality and equipment as would enable the reader to find the station and use the same. They also give, as far as possible, a complete history of all the changes that have occurred since the establishment of the station that would be factors in using the data collected.

The discharge-measurement table gives the results of the discharge measurements made during the year. This includes the date, the hydrographer's name, the gage height, and the discharge in second-feet. The table of daily gage heights gives for each day the mean height of the surface of the river as found from the mean of the gage readings taken on that day. At most of the stations the gage is read in the morning and in the evening.

The rating table gives discharges in second-feet corresponding to each stage of the river as given by the gage heights.

In the table of estimated run-off the column headed "Maximum" gives the mean flow for the day when the mean gage height was the highest, and it is the flow as given in the rating table for that mean gage height. As the gage height is the mean for the day, there might have been short periods when the water was higher and the corresponding discharge larger than given in this column. Likewise in the column of "Minimum" the quantity given is the mean flow for the day when the mean gage height was lowest. The column headed "Mean" gives the average flow for each second during the month. Upon this mean the computations for the three remaining columns which are defined on page 14 are based.

The results of stream measurements made during previous years by the United States Geological Survey can be found in the following Survey publications. A detailed index of these reports (1888–1903) is given in Water-Supply Paper No. 119.

1888. Tenth Annual Report, Part II.
1889. Eleventh Annual Report, Part II.
1890. Twelfth Annual Report, Part II.
1891. Thirteenth Annual Report, Part III.
1892. Fourteenth Annual Report, Part II.
1893. Bulletin No. 131.
1894. Bulletin No. 131, and Sixteenth Annual Report, Part II.
1895. Bulletin No. 140, and Seventeenth Annual Report, Part II.
1896. Water-Supply Paper No. 11; Eighteenth Annual Report, Part IV.
1897. Water-Supply Papers Nos. 15 and 16; Nineteenth Annual Report, Part IV.
1898. Water-Supply Papers Nos. 27 and 28; Twentieth Annual Report, Part IV.
1899. Water-Supply Papers Nos. 35 to 39, inclusive; Twenty-first Annual Report, Part IV.
1900. Water-Supply Papers, Nos. 47 to 52, inclusive; Twenty-second Annual Report, Part IV.
1901. East of Mississippi River, Water-Supply Papers Nos. 65 and 75. West of Mississippi River, Water-Supply Papers Nos. 66 and 75.
1902. East of Mississippi River, Water-Supply Papers Nos. 82 and 83. West of Mississippi River, Water-Supply Papers Nos. 84 and 85.
1903. East of Mississippi River, Water-Supply Papers Nos. 97 and 98. West of Mississippi River, Water-Supply Papers Nos. 99 and 100.
1904. East of Mississippi River, Water-Supply Papers Nos. 124 to 129, inclusive. West of Mississippi River, Water-Supply Papers Nos. 130 to 135, inclusive.

A limited number of these are for free distribution, and as long as the supply lasts the same may be obtained by application to the Director, United States Geological Survey. Aside from these, other copies are filed with the Superintendent of Public Documents, Washington, D. C., from whom they may be had at prices little above cost. Copies of Government publications are, as a rule, furnished to the public libraries in our large cities, where they may be consulted by those interested.

COOPERATION AND ACKNOWLEDGMENTS.

Most of the measurements presented in this paper have been obtained through local hydrographers. Acknowledgment is due to each of these persons, and thanks are extended to other persons and corporations who have assisted local hydrographers or have cooperated in any way, either by furnishing records of the height of water or by assisting in transportation.

The hydrographic work of the United States Geological Survey in California has been carried on in cooperation with the State, in accordance with an act of the State legislature approved March 16, 1903, which is in substance as follows:

> The State board of examiners are hereby empowered to enter into contracts with the Director of the United States Geological Survey for the purpose of making topographic maps, to the extent of twenty thousand dollars; also for the purpose of gaging streams, surveying reservoir sites and canal locations, for the conservation and utilization of the flood of storm waters of the State to the extent of fifteen thousand dollars, etc.

The State board of examiners is composed of the following members, viz: George C. Pardee, governor; C. F. Curry, secretary of State; U. S. Webb, attorney-general.

Although the portion of the new bill referring to hydrographic work provides for making surveys of reservoir sites and canal locations none of the State money has been expended for this purpose; the Geological Survey has made these investigations on Puta Creek, Sacramento River, Pit River and tributaries, Owens River, and Colorado River, and has paid the entire expense from its own funds.

The State appropriation, $7,500 of which became available July 1, 1903, has been used exclusively for gathering general stream-flow data; the Survey also apportioned $10,400 for the same purpose for the fiscal year beginning July 1, 1903. At this time 28 gaging stations were being maintained in California; other stations were added, and on December 31, 1904, 72 stations were being maintained. The data being accumulated for each of these stations have a specific value in connection with the future development of the resources of the State. The information will be invaluable in designing and making estimates of cost for storage, irrigation, power and drainage works, and for use in litigation.

The work in California is under the direction of Supervising Engineer J. B. Lippincott,[a] assisted by Hydrographers Samuel G. Bennett and W. B. Clapp. Acknowledgments are also due to the following individuals and corporations for assistance rendered and data furnished: To J. C. Pierson, city surveyor of Sacramento, Cal., for river stage and turbidity records of Sacramento River at Sacramento for 1904;

[a] The office of the supervising engineer is 1108 Braly Building, Los Angeles, Cal.

to the Kern County Land Company, through A. K. Warren, engineer in charge of water measurements, for the record of Kern River; to the McCloud River Power Company for river stage records during 1903 of McCloud River at Johns Camp; to the city of Santa Barbara for cooperation in gaging Santa Ynez River and Mono Creek; to the Southern Pacific Company through its chief engineer, William Hood, for river stage records of San Joaquin River at Herndon and King River at Kingsburg, Cal., and for transportation furnished the supervising engineer and assistants, and to the officials of the Santa Fe route for transportation furnished to the supervising engineer and assistants.

COLORADO RIVER DRAINAGE BASIN.

Topographically considered, this is the largest hydrographic basin lying wholly within the arid region, having a total area above the town of Yuma, Ariz., of over 225,000 square miles. It is situated in Wyoming, Utah, Colorado, Arizona, New Mexico, Nevada, and California, but the principal water supply comes from the melting snows of the high mountains of Wyoming. Utah, and Colorado. The minimum flow is less than 3,000 second-feet. The maximum reaches more than 75,000 second-feet. This stream has been called the Nile of America. Like the Nile, the Colorado is subject to an annual summer rise, which comes at a time when it is most needful for irrigation. Its waters carry a large amount of sediment, reaching as high as 2,000 parts of sediment to 100,000 parts of water. The minimum amount is carried during the winter months, and probably is never less than 60 parts of sediment to 100,000 parts of water.

Prof. R. H. Forbes, in Bulletin No. 44, University of Arizona agricultural experiment station, says:

> On the basis of the profile constructed from available data for the volume of flow of the Colorado and of the year's silt determinations made in this laboratory, it is estimated conservatively that the river during 1900 brought down about 61,000,000 tons of sedimentary material, which, condensed to the form of solid rock, is enough to cover 26.4 square miles 1 foot deep, or to make 53 square miles of dry, alluvial soil 1 foot deep, or to make about 164 square miles of recently settled, submerged mud 1 foot deep, reckoning the whole amount of mud for the year to average 6.2 times the bulk of the solid sediment.

A comparatively small amount of land is irrigated by the waters of Colorado River, owing to the fact that the main stream and both of its tributaries are situated so far below the level of the irrigable lands as to render their diversion extremely difficult or impracticable.

There are two pumping plants that lift water for irrigation at Yuma and several at other points on the river above Yuma. The Imperial canal diverts water at a point on the right bank of the river 10 miles, by river, below Yuma.

During December, 1901, and January, 1902, a reconnaissance of

Colorado River and Valley was made from The Needles and Yuma by J. B. Lippincott and others. In October, 1902, a reconnaissance was made by Mr. Lippincott, beginning at a point called Greggs Ferry, Mohave County, Ariz., and extending to The Needles, Cal.

Numerous dam and reservoir sites and diversion points for canals were discovered, together with large tracts of fertile land capable of being irrigated. In November, 1902, extensive topographic, soil, and hydrographic surveys were begun in the Colorado River Valley by the Reclamation Service of the United States Geological Survey.

The following is a list of the stations in the lower portion of Colorado River drainage basin: Colorado River at Yuma, Ariz.; Gila River at Yuma, Ariz.; Gila River at Gila City, Ariz.; Imperial canal at heading near Yuma, Ariz.; canals entering Imperial Valley; Colorado River at Bulls Head, Ariz.

COLORADO RIVER AT YUMA, ARIZ.

This station is located in the town of Yuma, Ariz., 1½ miles below the mouth of Gila River, and 10 miles, by river, above the Mexican boundary. Records of the river height have been kept by the Southern Pacific Railway Company since April 1, 1878, on the gage which was established by Arthur Brown, superintendent of the bridge and building department of the Southern Pacific Railway Company, during the summer of 1876. The lower section of the rod, reading from 10 to 22 feet, is nailed to the pile protection on the right bank of the Southern Pacific Railway bridge. The upper section, reading above 22 feet, is fastened on the lower side of the first bridge pier from the left bank. This gage height, plus 100 feet, is the Southern Pacific elevation above the sea level. At a later date the Southern Pacific Railway Company established a vertical gage rod (the old rod still remaining), fastened to the pile protection on the left bank of the river just below the railway bridge. This gage has been used continuously since it was established (date unknown) and is the one used by the United States Geological Survey at present. It corresponds in elevation to the old gage established in 1876. The gage is read twice a day by W. D. Smith, who is employed as local hydrographer for the stations in this vicinity.

Discharge measurements are made by means of a ¾-inch cable supported on masts. At low water measurements are made from a boat held in place by a cable. A car is used at flood stages. The initial point for soundings is the cable support on the south bank, about 20 feet from the water's edge at high water. The cable has a span of 650 feet. At low water the channel has a width of 325 feet. During floods a large part of the water flows through an old channel and does not pass under the cable. It is measured at the point where it passes under the railway trestle. The channel of the main river is

straight for 600 feet above and 5,000 feet below the station. The current is swift and the gaging section regular. The right bank is low, wooded, and liable to overflow. The left bank is not subject to overflow. The bed of the stream is composed of silt and sand and is very unstable. At low water a sand bar forms, which divides the channel into two parts. The bench mark is located on the first pier from the left bank. It is a standard bronze cap United States Geological Survey bench mark and has an elevation of 137 feet above sea level, as determined by the topographic branch of the Geological Survey. Its elevation above the zero of the gage is 35.31 feet.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Colorado River at Yuma, Ariz., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 2	W. D. Smith	18.92	3,981
January 5	do	18.84	4,007
January 8	do	18.75	3,677
January 11	do	18.60	3,494
January 14	do	18.55	3,418
January 16	do	18.70	3,512
January 19	do	18.60	3,407
January 21	do	18.75	3,694
January 23	do	18.75	3,586
January 26	do	18.70	3,511
January 28	do	18.75	3,595
January 30	do	18.80	3,622
February 1	do	18.85	3,649
February 4	do	18.90	3,812
February 6	do	18.90	3,736
February 9	do	18.75	3,484
February 11	do	18.70	3,342
February 13	do	18.75	3,540
February 16	do	18.75	3,490
February 18	do	18.95	3,753
February 20	do	19.05	3,794
February 22	do	19.20	4,162
February 25	do	19.35	4,229
February 27	do	19.25	4,247
March 1	do	19.45	4,446
March 3	do	19.50	4,627
March 5	do	19.55	4,725

Discharge measurements of Colorado River at Yuma, Ariz., in 1904—Continued.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
March 8	W. D. Smith	19.70	4,943
March 10	do	19.90	5,526
March 12	do	20.00	5,720
March 14	do	20.55	9,320
March 15	do	20.25	8,141
March 17	do	19.90	7,111
March 19	do	19.85	6,645
March 22	do	19.80	5,795
March 25	do	19.95	5,861
March 29	do	20.15	6,250
March 31	do	20.05	5,971
April 2	do	20.00	5,926
April 5	do	20.15	6,046
April 7	do	20.50	7,033
April 9	do	20.40	6,984
April 11	do	20.05	6,430
April 14	do	19.95	5,847
April 16	do	19.95	5,823
April 19	do	20.15	6,323
April 21	do	20.25	5,964
April 23	do	20.30	6,173
April 26	do	21.30	13,534
April 28	do	21.80	17,605
April 29	do	22.00	19,204
May 2	do	21.70	17,838
May 4	do	21.70	17,959
May 6	do	21.50	17,046
May 7	J. N. Johannsen	21.85	18,407
May 9	W. D. Smith	22.30	20,916
May 10	do	22.95	26,036
May 11	do	22.85	25,605
May 14	do	22.50	22,854
May 16	do	22.60	23,123
May 19	do	22.90	25,083
May 21	do	23.55	32,200
May 23	do	23.95	32,523
May 25	do	24.10	35,653
May 27	J. N. Johannsen	24.70	40,839
May 31	do	25.40	46,677
June 2	do	25.95	46,956

Discharge measurements of Colorado River at Yuma, Ariz., in 1904—Continued.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
June 5	W. D. Smith	26.25	49,485
June 7	do	26.00	51,170
June 9	do	25.90	49,183
June 11	do	25.50	45,820
June 13	N. J. Johannsen	24.90	42,295
June 15	W. D. Smith	24.70	34,256
June 17	do	24.80	38,192
June 20	do	25.00	38,981
June 22	do	25.40	43,202
June 24	do	25.70	45,435
June 27	do	25.65	43,706
June 29	do	25.55	44,909
July 2	J. N. Johannsen	25.15	35,701
July 5	do	24.25	32,421
July 7	W. D. Smith	24.00	32,186
July 9	S. M. Smith	23.80	27,608
July 11	do	23.40	23,675
July 13	do	23.00	22,761
July 15	do	23.05	22,269
July 18	do	22.85	21,050
July 21	do	22.55	18,681
July 22	do	22.50	18,178
July 25	do	22.20	15,269
July 28	do	22.25	16,044
July 30	do	21.90	13,939
August 1	do	22.20	16,193
August 4	do	22.25	15,973
August 6	do	21.85	15,427
August 8	do	22.15	16,357
August 12	W. D. Smith	21.95	17,686
August 16	do	21.95	16,660
August 18	do	21.65	14,636
August 20	do	21.50	14,199
August 23	do	21.30	12,957
August 24	do	23.00	23,652
August 26	do	22.25	18,740
August 30	S. M. Smith	22.80	23,185
September 1	do	22.10	18,358
September 5	do	22.00	18,060
September 7	do	22.40	18,351

Discharge measurements of Colorado River at Yuma, Ariz., in 1904—Continued.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
September 9	S. M. Smith	21.80	15,773
September 13	do	21.00	12,940
September 15	do	20.90	11,772
September 19	do	20.35	8,063
September 22	W. D. Smith	20.10	7,682
September 26	do	19.60	6,508
September 28	do	19.45	5,984
September 30	do	19.30	5,538
October 4	do	19.30	6,014
October 6	do	20.95	12,408
October 10	do	20.90	11,193
October 14	do	21.85	19,134
October 17	do	22.35	21,603
October 19	do	21.15	14,579
October 22	do	20.60	11,476
October 25	do	20.20	10,055
October 29	do	19.95	8,825
November 1	do	20.00	7,964
November 5	do	19.85	6,955
November 8	do	19.65	6,544
November 12	do	19.65	6,430
November 15	do	19.65	6,423
November 19	do	19.50	5,948
November 23	do	19.30	5,269
November 26	do	19.10	5,156
November 30	do	19.05	4,754
December 3	do	19.10	5,080
December 6	do	19.05	4,797
December 10	do	19.00	4,819
December 13	do	18.85	4,696
December 17	do	18.85	4,756
December 19	do	19.10	4,822
December 24	do	18.40	3,641
December 29	do	18.40	3,933

Mean daily gage height, in feet, of Colorado River at Yuma, Ariz., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	18.92	18.85	19.45	20.05	22.00	25.70	25.30	22.25	22.10	19.30	20.00	19.10
2	18.92	18.85	19.50	20.00	21.75	25.90	25.15	22.20	22.00	19.30	20.00	19.10
3	18.88	18.90	19.50	20.00	21.80	26.10	24.90	22.20	22.10	19.30	20.00	19.10
4	18.84	18.90	19.55	20.00	21.70	26.25	24.45	22.25	22.40	19.30	19.90	19.05
5	18.84	18.90	19.55	20.15	21.50	26.25	24.25	21.95	21.95	19.55	19.85	19.00
6	18.84	18.90	19.55	20.20	21.50	26.20	24.05	21.85	22.25	20.95	19.80	19.00
7	18.79	18.85	19.60	20.50	21.85	26.00	24.00	22.10	22.30	20.30	19.70	19.05
8	18.75	18.80	19.70	20.60	22.10	25.90	23.95	22.10	22.00	20.20	19.65	19.05
9	18.74	18.75	19.80	20.40	22.30	25.90	23.80	22.25	21.75	20.30	19.60	19.00
10	18.65	18.75	19.90	20.20	22.80	25.70	23.50	22.20	21.45	20.90	19.60	19.00
11	18.60	18.70	20.00	20.05	22.90	25.50	23.40	22.20	21.10	20.60	19.60	18.90
12	18.51	18.70	20.00	20.00	22.65	25.30	23.15	21.95	21.00	20.70	19.65	18.90
13	18.47	18.75	20.40	20.00	22.65	24.90	23.00	22.10	20.95	21.40	19.65	18.85
14	18.55	18.75	20.55	19.95	22.50	24.70	23.00	21.95	20.90	21.85	19.65	18.85
15	18.64	18.75	20.25	19.90	22.40	24.70	23.05	21.95	20.90	22.30	19.65	18.80
16	18.70	18.75	19.95	19.95	22.60	24.70	22.90	21.95	20.60	22.80	19.60	18.80
17	18.70	18.85	19.90	19.90	22.70	24.80	22.85	22.00	20.50	22.35	19.50	18.85
18	18.70	18.95	19.85	19.95	22.70	24.55	22.85	21.75	20.50	22.00	19.50	19.05
19	18.60	19.00	19.85	20.15	22.90	24.80	22.75	21.40	20.30	21.15	19.50	19.10
20	18.70	19.05	19.85	20.30	23.25	25.10	22.55	21.50	20.25	21.00	19.50	19.00
21	18.75	19.10	19.85	20.25	23.60	25.30	22.50	21.30	20.10	20.75	19.40	18.85
22	18.75	19.20	19.80	20.30	23.90	25.40	22.40	21.30	20.10	20.60	19.30	18.70
23	18.75	19.15	19.80	20.30	23.95	25.50	22.30	21.30	19.95	20.40	19.30	18.50
24	18.75	19.20	19.90	20.30	24.05	25.70	22.25	23.00	19.85	20.30	19.30	18.40
25	18.75	19.30	19.95	20.50	24.10	25.70	22.10	23.00	19.70	20.20	19.20	18.35
26	18.70	19.35	19.95	21.30	24.40	25.60	22.10	22.25	19.60	20.10	19.10	18.30
27	18.70	19.25	19.95	21.60	24.70	25.65	22.05	22.10	19.55	20.10	19.10	18.30
28	18.75	19.25	20.10	21.80	24.95	25.55	22.25	22.10	19.45	20.10	19.05	18.30
29	18.75	19.30	20.15	22.00	25.00	25.55	22.00	22.40	19.35	19.95	19.05	18.40
30	18.80	.....	20.15	22.00	25.05	25.50	22.00	22.90	19.30	19.95	19.05	18.60
31	18.80	.....	20.05	.....	25.30	.....	22.30	22.25	.....	19.95	.....	18.50

Estimated monthly discharge of Colorado River at Yuma, Ariz., for 1904.[a]

[Drainage area, 225,049 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	4,007	3,350	3,635	223,507	0.016	0.018
February	4,310	3,342	3,797	218,406	.017	.018
March	9,320	4,446	5,978	367,573	.027	.031
April	19,400	5,600	8,058	479,484	.036	.040
May	45,900	17,040	27,697	1,703,022	.123	.142
June	51,170	32,846	43,814	2,607,114	.195	.218
July	38,930	14,580	23,047	1,417,105	.102	.118
August	24,000	12,950	17,144	1,054,143	.076	.088
September	18,500	5,538	11,621	691,497	.052	.058
October	23,200	5,660	11,642	715,839	.052	.060
November	7,964	4,754	6,151	366,009	.027	.030
December	5,079	3,480	4,477	275,305	.020	.023
The year	51,170	3,342	13,922	10,119,004	.062	.844

[a] Computed by indirect method devised by W. B. Clapp. See article in Engineering News, April 21, 1904.

Summary of evaporation record at Yuma, Ariz., for 1904.

Month.	Evaporation.	Temperature.						Rain.	Net evaporation.
		Evaporation pan.		Reservoir.		River.			
		7 a. m.	6 p. m.	7 a. m.	6 p. m.	7 a. m.	6 p. m.		
January	3.60	49.4	53.3	50.6	54.3	47.9	49.8	0.00	3.60
February	3.90	58.2	62.7	59.7	63.3	56.1	60.0	.00	3.90
March	6.47	63.8	68.8	65.9	69.8	61.8	62.3	.28	6.19
April	9.37	65.7	72.5	68.2	73.3	65.1	69.2	.00	9.37
May	10.01	72.2	77.7	74.1	78.0	70.0	73.8	.07	9.94
June	10.11	79.3	84.0	81.4	84.1	77.2	80.8	.00	10.11
July	10.24	83.6	83.1	85.6	89.4	81.8	82.7	.05	10.19
August	8.56	86.8	91.7	88.9	92.5	85.5	89.6	.69	7.87
September	6.62	80.6	86.5	81.4	86.3	80.2	83.4	.24	6.38
October	7.02	66.5	71.3	86.7	72.0	65.3	68.4	.00	7.02
November	4.41	56.4	60.7	59.2	62.1	54.8	57.7	.00	4.41
December	2.01	49.9	53.2	52.2	54.3	48.2	49.9	.10	1.91
Total	82.32	.....	.....	.....	.....	.....	.....	1.43	80.89
Mean	.....	67.7	72.5	69.7	73.3	66.2	69.0	.....	.....

IMPERIAL CANAL AT CALIFORNIA-MEXICO BOUNDARY LINE.

Imperial canal heads about 10 miles, by river, below Yuma, Ariz., on the California side. The station is located a half mile from the river and 600 feet below the wooden head-gates. It was established October 24, 1903, by W. D. Smith. The vertical gage is located just above the boundary line on the right bank. It is read twice each day by J. S. Carter, the storekeeper. Discharge measurements are made by means of a boat and cable. The initial point for soundings is a charred post at the southeast corner of the corral about 150 feet west of the right bank. The channel is straight for 600 feet above and 300 feet below the cable and has a width of 70 feet. The velocity is moderate. There is but one channel at all stages, but when the gage at Yuma reads about 26 feet the river overflows into the channel below the gaging section. The bed of the canal is composed of silt and sand, free from vegetation, and is very unstable. The right bank is low and is liable to overflow. The left bank has an elevation of 6 feet above high water. Bench mark No. 1 is a standard United States Geological Survey iron bench-mark post. It is located near monument 207 of the United States and Mexico boundary line, on a hill

about half a mile west of the gaging station. Its elevation is 52.41 feet above the zero of the gage and 155 feet above sea level. Bench mark No. 2 is a nail in a tree on the right bank. Its elevation is 15.20 feet above the zero of the gage. Bench mark No. 3 is a nail in a post near the ground on the right bank near the corral. Its elevation is 14.90 feet above the zero of the gage.

On October 6, 1904, a new heading was opened on Mexican territory 4 miles below the original station for the diversion of additional water from Colorado River. Measurements were made in the canal below this heading, in order to obtain the total diversion.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Imperial canal at California-Mexico boundary line, head of canal (old gaging station), in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 1	W. D. Smith	8.60	455
January 15	do	8.30	410
January 27	do	8.30	408
February 12	do	8.30	438
February 26	do	8.82	551
March 16	do	10.16	780
Do	do	10.14	751
April 6	do	9.80	704
April 20	do	10.00	725
May 8	do	12.75	1,377
May 24	do	12.20	1,331
June 4	do	10.80	1,011
June 10	do	14.10	2,097
June 16	do	13.95	1,776
August 3	do	13.40	1,646
August 9	S. M. Smith	13.60	1,626
August 17	W. D. Smith	13.35	1,752
August 27	do	13.30	1,679
September 3	S. M. Smith	13.30	1,691
September 10	do	12.50	1,642
September 17	do	12.00	1,271
September 24	W. D. Smith	11.10	868
October 1	do	10.90	762

Mean daily gage height, in feet, of Imperial canal at California-Mexico boundary line, for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	8.60	8.50	8.90	9.60	12.85	11.05	14.70	13.60	13.30	10.90	.....	.....
2	8.60	8.50	9.00	9.60	12.70	11.00	14.70	13.50	13.20	10.90	.....	.....
3	8.55	8.50	9.00	9.60	12.70	11.00	14.65	13.40	13.20	10.85	.....	.....
4	8.50	8.50	9.05	9.60	12.60	10.95	14.60	13.35	13.55	10.85	.....	.....
5	8.55	8.50	9.10	9.60	12.30	10.80	14.55	13.10	13.10	12.70	.....	.....
6	8.50	8.45	9.05	9.75	12.25	11.30	(a)	13.00	13.45	12.10	.....	.....
7	8.50	8.40	9.05	9.95	12.60	11.80	.....	13.40	13.55	.....	.....	.....
8	8.50	8.35	9.10	10.15	12.85	13.10	.....	13.20	13.20	.....	.....	.....
9	8.45	8.30	9.20	10.00	13.00	13.80	.....	13.70	12.95	.....	.....	.....
10	8.40	8.20	9.30	10.00	13.35	14.00	.....	13.60	12.55	12.60	.....	.....
11	8.35	8.35	9.45	9.90	13.50	13.95	.....	13.65	12.10	.....	.....	.....
12	8.30	8.35	9.55	9.90	13.00	14.10	.....	13.45	12.05	.....	.....	.....
13	8.20	8.35	9.95	9.80	12.70	b14.20	.....	13.45	12.10	.....	.....	.....
14	b8.25	8.40	10.70	9.85	12.00	14.30	.....	13.40	12.05	.....	.....	.....
15	b8.25	8.40	10.50	9.90	11.90	14.10	.....	13.20	12.10	14.15	.....	.....
16	b8.25	8.40	10.20	9.90	12.15	14.00	.....	13.30	11.90	(c)	.....	.....
17	b8.25	8.50	10.05	9.95	12.30	14.05	.....	13.25	11.95	.....	.....	.....
18	8.30	8.60	9.95	9.80	12.45	14.10	.....	12.85	11.80	.....	.....	.....
19	8.30	8.60	9.85	9.85	12.70	14.25	.....	12.70	11.65	.....	.....	.....
20	8.30	8.60	9.80	10.00	12.70	14.45	.....	12.70	11.55	.....	.....	.....
21	8.40	8.60	9.60	10.10	12.55	14.60	.....	12.60	11.30	.....	.....	.....
22	8.40	8.70	9.60	10.10	12.25	14.60	.....	12.55	11.20	.....	.....	.....
23	8.40	8.70	9.50	10.15	12.20	14.60	.....	12.50	11.20	.....	.....	.....
24	8.45	8.70	9.50	10.10	12.20	14.60	.....	13.85	11.20	.....	.....	.....
25	8.35	8.70	9.60	10.20	12.15	14.60	.....	14.10	11.15	.....	.....	.....
26	8.35	8.80	9.60	11.85	11.80	14.70	.....	13.50	11.15	.....	.....	.....
27	8.30	8.80	9.65	12.50	11.00	14.75	13.10	13.20	11.20	.....	.....	.....
28	8.40	8.80	9.65	12.80	11.15	14.70	13.05	13.30	11.10	.....	.....	.....
29	8.40	8.80	9.65	12.80	11.15	14.70	13.00	13.55	11.05	.....	.....	.....
30	8.40	.....	9.70	12.80	11.00	14.70	13.40	14.10	10.90	.....	.....	.....
31	8.40	.....	9.80	.....	10.50	.....	13.55	13.50	.....	.....	.....	.....

a Gage destroyed. Replaced July 27. b Estimated. c Station discontinued.

Discharge measurements of Imperial canal at heading in Mexico, 4 miles below the International boundary line (new gaging station), in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
October 7	W. D. Smith	10.60	1,213
October 15	do	12.75	1,976
October 21	do	10.60	1,356
October 28	do	9.35	1,016
November 4	do	9.30	898
November 11	do	9.20	937
November 18	do	8.95	954
November 25	do	8.85	886
December 2	do	8.60	826
December 9	do	8.85	879
December 20	do	8.90	899
December 28	do	8.00	607

IMPERIAL VALLEY CANALS.

In July, 1904, stations were established on all canals entering the Imperial Valley as follows: Holt canal, Hemlock canal, Alamo channel, Alamitos canal, Main canal, and Boundary canal. These stations are located on United States territory and in each case near the California-Mexico boundary line. Discharge measurements are made from foot-bridges constructed at each station. The gages are vertical rods fastened to 4 by 4 inch timbers substantially imbedded in the ground. Automatic water-stage registers, from which the daily gage height record is compiled, were placed at the first five stations mentioned above. These canals enter the valley east of Calexico, Cal. In October a canal, known as Canal No. 6, was completed, which enters the valley west of Calexico, Cal. A station was constructed on this canal in November, and weekly discharge measurements are being made. A large quantity of waste water was discharging from the Imperial Valley, below all irrigated lands, into the Salton Basin. To determine this waste, discharge measurements were made on New River at Brawley, on Alamo channel at Rockwood, and on Canal No. 5 at Bernice.

The observations at these stations during 1904 have been made under the direction of W. B. Clapp, district hydrographer.

Discharge measurements of Holt canal near Calexico, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
July 14	W. V. Hardy	2.02	62.0
July 23	do	1.79	53.6
July 26	do	1.75	48.4
July 29	do	1.72	44.0
August 2	do	1.70	43.0
August 5	do	1.70	41.8
August 10	do	1.88	50.0
August 17	do	2.03	59.0
August 23	do	1.96	56.0
August 26	do	1.97	56.0
September 3	W. V. Hardy and E. C. La Rue	2.03	60.0
September 10	do	2.14	61.0
September 18	do	1.63	37.0
September 24	S. M. Smith	1.60	36.0
September 27	do	1.55	33.0
October 1	do	1.90	49.0
October 5	do	1.73	41.0
October 8	do	2.03	56.0

Discharge measurements of Holt canal near Calexico, Cal., in 1904—Continued.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
October 15	S. M. Smith	1.97	48.0
October 22	do	1.98	47.0
October 29	do	1.61	30.0
November 4	do	1.62	36.3
November 11	W. V. Hardy and S. M. Smith	1.95	54.0
November 18	W. V. Hardy	1.92	50.0
November 25	do	1.72	40.0
December 2	do	1.52	32.0
December 8	do	1.65	37.0
December 15	do	1.46	27.0
December 22	do	1.58	32.0

Mean daily gage height, in feet, of Holt canal near Calexico, Cal., for 1904.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		1.85	2.00	1.90	1.60	1.60
2		1.70	2.10	1.80	1.55	1.55
3		1.70	2.00	1.80	1.55	1.50
4		1.70	2.00	1.80	1.60	1.55
5		1.70	2.00	1.75	1.70	1.60
6		1.65	1.90	1.70	1.80	1.75
7		1.60	1.90	1.80	1.65	1.65
8		1.80	2.10	2.00	2.15	1.65
9		1.85	2.10	2.00	2.15	1.60
10		1.90	2.15	1.85	2.05	1.60
11		1.90	2.15	1.80	2.00	1.65
12		1.90	2.10	1.85	1.90	1.65
13		1.95	1.90	1.90	1.90	1.65
14		1.95	1.70	1.85	1.90	1.60
15		2.00	1.65	1.80	1.85	1.50
16		2.00	1.60	1.90	1.85	1.50
17		2.05	1.55	1.90	1.90	1.45
18		2.05	1.60	1.95	1.90	1.50
19		2.05	1.60	1.95	1.90	1.50
20		(2.05)	1.60	1.95	1.90	1.45
21		(2.05)	1.65	2.00	1.85	1.55
22	1.80	(2.00)	1.55	1.95	1.85	1.55
23	1.80	1.95	1.55	1.85	1.80	1.45
24	1.75	(1.95)	1.55	1.75	1.75	1.25
25	1.70	(1.95)	1.55	1.60	1.75	1.20
26	1.75	1.95	1.50	1.65	1.75	1.05
27	1.80	2.00	1.55	1.70	1.75	1.10
28	1.75	2.05	1.50	1.65	1.70	1.05
29	1.70	2.00	1.50	1.60	1.70	(1.05)
30	1.35	1.90	1.70	1.60	1.65	(1.05)
31	1.90	2.00		1.60		(1.05)

NOTE.—Gage heights in parenthesis are estimated.

Discharge measurements of Hemlock canal near Calexico, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
July 23	W. V. Hardy	0.95	4.4
July 26	do	1.15	6.4
July 29	do	1.14	6.0
August 2	do	.92	3.6
August 5	do	1.20	7.3
August 10	do	1.00	4.4
August 17	do	1.08	5.7
August 23	do	1.03	5.0
August 26	do	1.02	4.9
September 3	W. V. Hardy and E. C. La Rue	1.02	4.3
September 10	do	1.07	4.6
September 18	do	1.44	11.5
September 24	S. M. Smith	1.10	3.9
September 27	do	1.10	4.5
October 1	do	1.79	14.5
October 5	do	1.15	5.4
October 8	do	1.31	8.2
October 15	do	1.45	8.8
October 22	do	1.50	10.6
October 29	do	.98	3.1
November 4	do	1.13	6.4
November 11	W. V. Hardy and S. M. Smith	1.29	8.0
November 18	W. V. Hardy	1.31	8.2
November 25	do	1.28	8.0
December 2	do	1.39	9.5
December 8	do	1.13	6.3
December 15	do	1.04	3.3
December 22	do	.88	1.8

Mean daily gage height, in feet, of Hemlock canal near Calexico, Cal., for 1904.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	0.95	0.95	1.70	1.05	1.20
2	.....	.90	.95	1.50	1.10	1.40
3	.....	.95	1.00	1.40	1.15	1.40
4	.....	1.10	1.05	1.35	1.15	1.40
5	.....	1.20	1.05	1.15	1.20	1.30
6	.....	1.30	1.05	1.05	1.25	.95
7	.....	(a)	1.05	1.05	1.35	1.15
8	.....	(a)	1.05	1.15	1.40	1.15
9	.....	.90	1.05	.85	1.35	1.10
10	.....	1.00	1.10	.80	1.30	1.10
11	.....	1.00	1.10	.75	1.30	1.10
12	.....	.80	1.05	.65	1.30	1.10
13	.....	.90	1.05	.95	1.30	1.10
14	.....	1.05	1.00	1.30	1.30	1.10
15	.....	1.05	1.05	1.45	1.35	1.00
16	.....	1.05	1.10	1.45	1.45	1.00
17	.....	1.10	1.05	1.45	1.45	.95
18	.....	1.05	1.20	1.45	1.35	.95
19	.....	1.10	1.65	1.45	1.30	.90
20	.....	(1.05)	1.35	1.50	1.30	.90
21	.....	(1.05)	1.10	1.50	1.30	.90
22	1.00	(1.05)	1.00	1.50	1.30	.90
23	.95	1.05	1.00	1.45	1.30	.85
24	1.00	(1.05)	1.00	1.35	1.30	.80
25	1.05	(1.00)	1.05	1.25	1.30	.80
26	1.15	1.00	1.10	1.15	1.30	.65
27	1.15	(1.05)	1.25	1.05	1.30	.60
28	.75	(1.05)	1.45	1.00	1.30	.75
29	1.15	(1.20)	1.35	1.00	1.25	(.75)
30	1.15	(1.25)	1.35	1.05	1.20	(.75)
31	1.00	(1.05)	.....	1.05	.....	(.75)

a Dry.

NOTE.—Gage heights in parenthesis are estimated.

Discharge measurements of Alamo channel near Calexico, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
July 14	W. V. Hardy	3.20	144
July 23	do	2.80	115
July 26	do	3.09	138
July 29	do	3.51	177
August 2	do	1.63	39
August 5	do	1.61	36.5
August 10	do	3.38	163
August 17	do	3.82	219
August 23	do	3.67	200
August 26	do	3.68	197
September 3	W. V. Hardy and E. C. La Rue	4.00	239
September 10	do	4.00	256
September 18	do	2.95	136
September 24	S. M. Smith	2.77	124
September 27	do	2.80	135
October 1	do	3.79	240
October 5	do	2.65	123
October 8	do	3.55	205
October 15	do	3.40	182
October 22	do	3.82	228
October 29	do	3.05	157
November 4	do	2.97	146
November 11	W. V. Hardy and S. M. Smith	3.04	152
November 18	W. V. Hardy	2.43	97
November 25	do	2.22	86
December 2	do	2.14	80
December 8	do	2.56	107
December 15	do	2.55	111
December 22	do	2.32	80

Mean daily gage height, in feet, of Alamo channel near Calexico, Cal., for 1904.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.80	(3.90)	3.75	2.95	2.10
2	.....	1.65	(3.90)	3.35	2.95	2.15
3	.....	1.65	4.00	3.00	2.95	2.15
4	.....	1.60	4.00	(2.70)	3.00	2.20
5	.....	1.60	4.00	2.65	2.70	2.30
6	.....	1.80	4.00	3.55	2.50	2.35
7	.....	2.50	4.00	2.75	2.50	2.55
8	.....	2.65	4.00	3.25	(3.00)	2.55
9	.....	2.85	4.00	3.50	(3.00)	2.55
10	.....	3.40	4.00	3.45	(3.00)	2.60
11	.....	3.60	4.00	3.40	3.00	2.60
12	.....	3.60	3.95	3.40	2.75	2.60
13	.....	3.50	3.65	3.40	2.50	2.60
14	.....	3.65	3.35	3.35	(2.40)	2.55
15	.....	3.65	(3.00)	3.40	(2.40)	2.55
16	.....	3.75	(2.90)	3.45	(2.40)	(2.55)
17	.....	3.80	(2.90)	3.40	(2.40)	(2.55)
18	.....	3.80	2.90	3.50	2.40	(2.50)
19	.....	3.80	2.90	3.75	2.40	(2.50)
20	.....	3.80	2.90	3.80	3.40	(2.40)
21	.....	3.80	2.80	3.85	2.35	(2.35)
22	3.25	3.80	2.70	3.80	2.30	2.30
23	2.80	3.65	2.75	3.70	2.25	2.15
24	2.90	3.65	2.75	3.25	2.25	2.00
25	2.95	3.70	2.80	3.20	2.20	(2.00)
26	3.10	3.70	2.75	3.25	2.25	(2.00)
27	3.30	3.80	2.80	3.15	2.25	(1.90)
28	3.40	3.80	2.75	3.05	2.20	(1.80)
29	3.50	3.80	2.95	3.00	2.15	1.75
30	3.60	3.80	3.40	3.00	2.10	(1.75)
31	3.80	3.80	.....	2.95	.....	(1.75)

NOTE.—Gage heights in parenthesis are estimated.

Discharge measurements of Alamitos canal near Calexico, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
July 14	W. V. Hardy	1.40	26.6
July 23	do	1.48	24.3
July 26	do	1.30	18.4
July 29	do	1.50	26.3
August 2	do	1.08	8.2
August 5	do	1.04	13.3
August 10	do	.81	3.0
August 17	do	1.20	17.7
August 23	do	1.17	17.4
August 26	do	1.13	15.6
September 3	do	1.10	16.3
September 10	do	1.15	21.0
September 18	do	1.39	31.0
September 24	S. M. Smith	.87	8.3
September 27	do	1.02	13.7
October 1	do	1.10	8.4
October 5	do	1.19	18.7
October 8	do	1.54	36.0
October 15	do	1.50	35.0
October 22	do	1.30	26.0
October 29	do	1.24	25.0
November 4	do	1.21	23.0
November 11	S. M. Smith and W. V. Hardy	1.37	30.0
November 18	W. V. Hardy	1.48	35.0
November 25	do	1.48	26.0
December 2	do	1.34	22.0
December 8	do	1.41	25.0
December 15	do	1.43	26.0
December 22	do	1.46	29.0

Mean daily gage height, in feet, of Alamitos canal near Calexico, Cal., for 1904.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.00	(1.10)	1.10	1.25	1.35
2	.....	1.10	(1.10)	.65	1.25	1.35
3	.....	1.10	1.10	.90	1.25	1.35
4	.....	1.05	1.05	1.15	1.25	1.35
5	.....	1.05	1.10	1.25	1.30	1.35
6	.....	1.00	1.10	1.30	1.35	1.40
7	.....	1.00	(1.10)	1.40	1.25	1.40
8	.....	.90	1.15	1.45	1.20	1.40
9	.....	1.00	1.15	1.35	1.25	1.50
10	.....	.80	1.15	1.35	1.30	1.60
11	.....	.90	1.15	1.35	1.35	1.45
12	.....	.85	1.20	1.35	1.45	1.40
13	.....	.95	1.15	1.40	1.45	1.45
14	.....	1.00	1.15	1.45	1.45	1.45
15	.....	1.10	1.10	1.50	1.45	1.45
16	.....	1.15	1.15	1.55	1.45	1.45
17	.....	1.20	1.25	1.10	1.45	1.45
18	.....	1.20	1.40	.90	1.50	1.45
19	.....	1.20	1.30	.80	1.45	1.45
20	.....	(1.20)	1.25	1.15	(a)	1.50
21	.....	1.15	1.15	1.35	(a)	1.50
22	1.40	(1.10)	1.10	1.30	1.35	1.45
23	1.50	1.10	1.00	1.30	1.40	1.40
24	1.40	(1.05)	.95	1.25	1.40	1.35
25	1.35	(1.05)	1.10	1.25	1.40	1.25
26	1.30	1.05	1.05	1.25	1.40	1.20
27	1.35	1.05	1.05	1.25	1.40	1.30
28	1.40	(1.05)	1.10	1.25	1.40	1.40
29	1.50	(1.05)	1.15	1.25	1.40	(1.40)
30	1.50	(1.00)	1.00	1.25	1.40	(1.40)
31	1.65	(1.00)	.....	1.25	.....	(1.40)

a Dry.

NOTE.—Gage heights in parenthesis are estimated.

Discharge measurements of Imperial canal (main) near Calexico, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
July 14	W. V. Hardy	4.60	615
July 21	do	4.60	642
July 23	do	4.53	625
July 26	do	4.32	598
July 29	do	4.03	519
August 2	do	4.73	652
August 5	do	4.83	677
August 10	do	4.16	556
August 17	do	4.72	644
August 23	do	4.74	669
August 26	do	4.76	696
September 3	do	4.93	717
September 10	do	4.91	682
September 18	do	4.62	662
September 24	do	4.27	573
September 27	S. M. Smith	4.10	560
October 1	do	3.11	249
October 5	do	3.97	474
October 8	do	4.13	548
October 15	do	4.59	642
October 22	do	4.70	639
October 29	do	4.63	656
November 4	S. M. Smith and W. V. Hardy	4.45	598
November 11	do	4.41	601
November 18	W. V. Hardy	4.62	620
November 25	do	4.54	602
December 2	do	4.48	586
December 8	do	4.45	573
December 15	do	4.42	561
December 22	do	4.40	563

Mean daily gage height, in feet, of Imperial canal (main) near Calexico, Cal., for 1904.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	4.60	4.85	2.90	4.50	4.50
2	.....	4.75	4.90	3.50	4.50	4.45
3	.....	4.70	4.95	3.80	4.45	4.45
4	.....	4.85	4.90	4.05	4.45	4.45
5	.....	4.80	4.90	4.00	4.50	4.50
6	.....	4.80	4.90	3.95	4.55	4.50
7	.....	4.70	4.90	4.00	4.25	4.45
8	.....	4.55	4.90	4.15	4.25	4.45
9	.....	4.40	4.90	4.25	4.30	4.45
10	.....	4.15	4.90	4.40	4.35	4.40
11	.....	4.20	4.90	4.40	4.40	4.45
12	.....	4.30	4.85	4.40	4.50	4.45
13	.....	4.40	4.80	4.40	4.55	4.45
14	4.60	4.55	4.75	4.55	4.55	4.40
15	4.60	4.65	4.75	4.60	4.55	4.40
16	4.70	4.65	4.75	4.60	4.60	(4.40)
17	4.60	4.70	4.65	4.70	4.60	(4.40)
18	4.60	4.75	4.60	4.75	4.60	(4.40)
19	4.60	4.90	4.60	4.80	4.65	(4.40)
20	4.60	4.75	4.55	4.75	4.70	(4.40)
21	4.60	4.75	4.55	4.70	4.70	(4.40)
22	4.55	4.75	4.50	4.70	4.60	4.40
23	4.55	4.75	4.35	4.65	4.55	4.35
24	4.50	4.75	4.15	4.65	4.55	4.30
25	4.45	4.75	4.10	4.60	4.55	4.20
26	4.30	4.75	4.10	4.65	4.55	4.15
27	4.25	4.80	4.15	4.60	4.60	4.10
28	4.00	4.80	4.15	4.60	4.55	4.00
29	4.00	4.85	4.10	4.65	4.55	(4.00)
30	4.00	4.85	3.30	4.60	4.50	(4.00)
31	4.10	4.85	.....	4.55	.....	(4.00)

NOTE.—Gage heights in parenthesis are estimated.

Discharge measurements of Boundary canal near Calexico, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
July 23	W. V. Hardy	1.20	10.0
July 26	do	1.20	10.0
July 29	do	1.15	9.1
August 2	do	1.65	12.7
August 5	do	1.10	13.0
August 10	do	1.06	10.5
August 17	do	.91	8.3
August 23	do	.85	11.9
August 26	do	1.10	15.6
September 3	W. V. Hardy and E. C. LaRue	1.07	13.2
September 10	do	1.08	12.9
September 18	do	.85	7.5
September 24	S. M. Smith	.99	11.0
September 27	do	.90	9.9
October 1	do	1.00	10.8
October 5	do	1.00	10.0
October 8	do	1.00	9.4
October 15	do	.90	5.9
October 22	do	.10	7.0
October 29	do	.10	7.0
November 4	W. V. Hardy	.78	6.2
November 11	S. M. Smith and W. V. Hardy	.85	6.6
November 18	W. V. Hardy	.82	6.3
November 25	do	.82	6.2
December 2	do	.84	7.0
December 8	do	.65	4.8
December 15	do	.74	5.5
December 22	do	.46	4.0

Waste measurements in Imperial Valley in 1904.

Date.	Hydrographer.	Stream.	Location.	Discharge.
October 10	W. V. Hardy and S. M. Smith.	New River	Brawley, Cal	208
October 11	do	Alamo channel	Rockwood, Cal.	43
		Canal No. 5	Bernice, Cal	([a])
October 18	S. M. Smith	New River	Brawley, Cal	380
October 18	do	Alamo channel	Rockwood, Cal.	45
October 19	do	Canal No. 5	Bernice, Cal	77
		Total waste		502
October 31	W. V. Hardy and S. M. Smith.	New River	Brawley, Cal	381
November 1	do	Alamo channel	Rockwood, Cal.	59
November 1	do	Canal No. 5	Bernice, Cal	58
		Total waste		498
November 9	W. V. Hardy	New River	Brawley, Cal	318
November 9	do	Alamo channel	Rockwood, Cal.	49
November 9	do	Canal No. 5	Bernice, Cal	0
		Total waste		367
November 16	do	New River	Brawley, Cal	270
November 15	do	Alamo channel	Rockwood, Cal.	117
November 15	do	Canal No. 5	Bernice, Cal.	1
		Total waste		388
November 24	do	New River	Brawley, Cal	311
November 22	do	Alamo channel	Rockwood, Cal.	81
November 22	do	Canal No. 5	Bernice, Cal	3
		Total waste		395
November 30	do	New River	Brawley, Cal	231
November 30	do	Alamo channel	Rockwood, Cal.	73
November 30	do	Canal No. 5	Bernice, Cal	0
		Total waste		304
December 6	do	New River	Brawley, Cal	257
December 6	do	Alamo channel	Rockwood, Cal.	46
December 6	do	Canal No. 5	Bernice, Cal	0
		Total waste		303
December 13	do	New River	Brawley, Cal	301
December 13	do	Alamo channel	Rockwood, Cal.	52
December 13	do	Canal No. 5	Bernice, Cal	0
		Total waste		353
December 24	W. V. Hardy	New River	Brawley, Cal	254
December 24	do	Alamo channel	Rockwood, Cal.	39
December 24	do	Canal No. 5	Bernice, Cal	0
		Total waste		293

[a] No measurement made.

Miscellaneous measurements in Colorado River drainage basin in 1904.

Date.	Hydrographer.	Stream.	Location.	Gage height.	Discharge.
				Feet.	*Sec.-ft.*
February 22	W. D. Smith and S. M. Woodward.	Colorado Valley Pumping and Irrigation Company canal.	At heading.	1.11	19.8
February 22	do	do	do		9.9
February 23	do	do	do	.89	11.5
February 23	do	do	do		11.8
February 23	do	do	do		11.8
February 23	do	do	do		11.2
May 8	W. D. Smith	Ludy canal	do		50
May 24	do	do	do		59
June 4	do	do	do		158
June 16	do	do	do		92
July 27	do	do	do		185
May 8	do	Farmers canal	do		63
May 24	do	do	do		97
June 4	do	do	do		56
June 16	do	do	do		35
July 27	do	do	do		47
August 9	S. M. Smith	do	do		70
August 4	W. D. Smith	Imperial canal	Junction with Carter River, Mexico.		309
August 3	do	Main channel Imperial canal.	Below Best's Camp, Mexico.		525
August 3	do	Padrone River diversion (waste from Imperial canal.)	Best's Camp, Mexico.		609
October 12	S. M. Smith	New River	Calexico, Cal.		154
November 2	W. V. Hardy and S. M. Smith.	do	do		52
November 10	S. M. Smith	do	do		28
November 17	W. V. Hardy	do	do		24
November 23	do	do	do		20
December 1	do	do	do		18.6
December 7	do	do	do		16.7
December 14	do	do	do		22
December 21	do	do	do		10.2

DUTY OF WATER AND SEEPAGE INVESTIGATIONS NEAR YUMA, ARIZ.

[By W. D. Smith.]

The following is a statement of the investigations made on the duty of water for mixed crops under the right and left branches of the Colorado Valley Pumping and Irrigation Company canal, the duty of water for alfalfa on the Laselle and Rose ranches, and the seepage loss in the left branch of the Colorado Valley Pumping and Irrigation Company canal (commonly known as the Ives ditch). All of these lands lie in the upper part of the Yuma Valley, within 6 miles of Yuma, where the pumping plant is located. The results are representative of the Yuma project as a whole, with the exception of the seepage loss, which is believed to be somewhat high.

The climatic conditions have been normal. At the end of the year the zanjero, Mr. S. P. Huss, was asked if he thought the amount of water used was more or less than usual, and he said, "Probably a little less, for the following reasons: Colorado River during the months of August, September, and October has carried an abnormal amount of fine light mud, due to the heavy discharge of Gila River and other Arizona streams. This was carried through the canals to the lands irrigated and prevented the water from soaking in readily. In the same way seepage in the ditches was reduced." Mr. Huss states that he observed a marked difference in the amount of time it required to irrigate the same acreage with a given head of water, and that this was not entirely offset by more frequent irrigations. The alfalfa crop appears to have been slightly reduced from this cause. The water costs the irrigators $1 or more per acre-foot and is, therefore, not wasted, but the scattering location of the farms and the slow velocity of water in the canals and laterals increases the amount lost by seepage. The areas were obtained from the best available sources. The Laselle and Rose ranches were surveyed by the writer.

Four measuring flumes were used, on which nilometer records were kept. Weir measurements would have been unsatisfactory on account of the large amount of sediment carried in the water. The rating of these flumes was constantly changing by the steady filling of the canals with silt. This necessitated frequent ratings, or single-meter measurements, and at the end of the year, or just before the cleaning of the canal of silt, tables were constructed for periods of from two weeks to two or three months, according to conditions.

Another serious difficulty was the light grade of the canals and the fact that they were discharging nearly their full capacity. This made it almost impossible to locate the flumes where the rating would not be affected by check gates in the canal. In the case of flumes Nos. 2 and 4 this might have been overcome by locating them above the company's weirs, but the advantages would have been offset by the

fact that here the canals are more often cleaned of silt. The flumes were rated with the check gates removed and with them in place, designated as "rating *a*" and "rating *b*," respectively. This would not have been a complete success without the hearty cooperation of Mr. S. P. Huss, the zanjero, in operating the check gates and keeping a record of the same when requested; also the cooperation of Messrs. J. M. Boxley and John Lamar, managers of the Laselle and Rose ranches, respectively.

By the kindness of the engineer, Mr. H. Alexander, another check was obtained on the "*a*" and "*b*" ratings and on the clock records as a whole. Mr. Alexander kept an accurate record for the whole year of the number of hours the pump was in operation each day and the number of irrigating heads pumped. An irrigating head is about 12 second-feet.

Flume No. 4 is the property of the agricultural experiment station at Tucson, Ariz. The nilometer on this flume is of French make. The other three were manufactured by Julian P. Friez, of Baltimore, Md. The French machine gave much better results than the latter. In carrying out this work no impossible degree of accuracy has been attempted, but no pains have been spared to make the results absolutely reliable and reasonably accurate.

Monthly duty of water of right branch of Colorado Valley Pumping and Irrigation Company canal at Yuma, Ariz.

Month.	Acre-feet.	
	Total.	Per acre.
January	356.0	0.20
February	517.9	.29
March	1,188.5	.66
April	966.2	.54
May	966.3	.54
June	1,284.6	.71
July	1,033.1	.57
August	576.9	.32
September	794.0	.44
October	748.4	.41
November	0.0	.00
December	316.0	.18
Total	8,747.8	4.86

NOTE.—The above includes seepage losses. Crops, mixed. Net area, 1,800 acres.

Monthly duty of water of left branch of Colorado Valley Pumping and Irrigation Company canal at Yuma, Ariz.

Month.	Acre-feet.	
	Total.	Per acre.
January	100.7	0.22
February	105.5	.23
March	174.5	.39
April	249.6	.55
May	243.8	.54
June	398.0	.88
July	330.8	.73
August	245.8	.55
September	204.0	.45
October	223.9	.50
November	0.0	.00
December	51.5	.11
Total	2,328.1	5.15

NOTE.—The above includes seepage losses. Crops, mixed. Net area, 450 acres.

Monthly duty of water at Laselle ranch, Yuma, Ariz.

Month.	Acre-feet.	
	Total.	Per acre alfalfa.
January	76.0	0.58
February	48.5	.37
March	64.3	.49
April	66.9	.51
May	109.1	.83
June	53.3	.40
July	140.7	1.07
August	65.3	.49
September	80.9	.61
October	74.9	.57
November	0.0	.00
December	0.0	.00
Total	779.9	5.92

NOTE.—Acreage, net: Alfalfa, 128 acres; wheat, 17 acres; total, 145 acres; which is equivalent to 132 acres of alfalfa.

REMARKS.—The measuring flume is 1,100 feet above the first lateral, so that the loss by seepage after passing the flume and before reaching the ranch is probably about 1 per cent. The soil is very sandy. Most of the alfalfa was cut, but a part was used as pasture. Plenty of water was used, but apparently none was wasted.

Monthly duty of water at Rose ranch, Yuma, Ariz.

Month.	Acre-feet.	
	Total.	Per acre.
January	0.0	0.00
February	0.0	.00
March	13.8	.72
April	15.2	.79
May	10.0	.52
June	14.9	.77
July	12.3	.64
August	8.0	.42
September	8.2	.43
October	13.8	.72
November	0.0	.00
December	2.2	.11
Total	98.4	5.12

NOTE.—Acreage, net: Alfalfa, 19.26 acres.

REMARKS.—7.19 acres of above was wheat and young alfalfa so irrigated as to make total equivalent to 17.7 acres of old alfalfa. These measurements were made at the ranch and do not include loss by seepage.

Monthly duty of water of Colorado Valley Pumping and Irrigation Company canal at Yuma, Ariz.

	Acre-feet.		
	Total.	Per acre gross area.	Per acre net area.
January	456.7	0.07	0.20
February	623.4	.10	.28
March	1,363.0	.21	.60
April	1,215.0	.19	.54
May	1,210.1	.19	.54
June	1,682.6	.26	.75
July	1,363.9	.21	.60
August	822.7	.13	.37
September	998.0	.15	.44
October	972.2	.15	.43
November	0.0	.00	.00
December	367.5	.06	.16
Total	11,075.9	1.72	4.91

NOTE.—The above includes loss by seepage.

REMARKS.—Mixed crops: Alfalfa, 1,365 acres; grain, 475 acres; corn and sorghum, 245 acres; miscellaneous, 165 acres. Total net area, 2,250 acres; total gross area, 6,500 acres. Number of irrigators, 75.

Cost of pumping, Colorado Valley Pumping and Irrigation Company canal, at Yuma, Ariz.

Irrigation No.	Month.	Hours pumping.	Acre-feet pumped.	Average lift.	Expense.	Cost per acre-foot.	Cost per foot of raising 1 acre-foot.
1	January	156	457	11.5	$240	$0.53	$0.046
2	February	342	1,173	10.8	564	.48	.044
3	March	230	816	10.5	411	.50	.048
4	April	380	1,216	10.1	607	.50	.050
5	May	183	582	8.7	312	.54	.062
6	May	213	628	7.5	310	.50	.067
7	June	200	623	5.1	271	.43	.084
8	June	220	685	6.4	311	.45	.070
9	June	240	718	6.3	330	.46	.073
10	July	220	706	8.3	362	.51	.061
11	August	300	644	8.9	345	.54	.061
12	August	200	439	8.9	260	.59	.066
13	September	180	480	8.9	340	.71	.080
14	September	175	572	10.7	354	.62	.058
15	October	200	574	9.7	310	.54	.056
16	October	200	456	10.1	302	.66	.065
17	December	180	368	11.4	315	.86	.075
	Total	3,819	11,079	9.05	5,944	.54	.060

NOTE.—The engineer's salary is $100 per month, and this increased the cost per acre-foot in the months when little water was pumped.

Monthly expense.

Month.	Labor.	Wood.	Oil.	Miscellaneous.	Total.
January	$88	$126	$0	$17	$231
February	132	4	170	27	333
March	174	91	320	45	630
April	180	88	312	26	606
May	172	91	305	32	600
June	188	130	340	32	690
July	190	140	328	36	694
August	174	10	352	30	566
September	158	63	280	35	536
October	172	80	288	51	591
November	100	0	0	9	109
December	134	70	80	74	358
Total	1,862	893	2,775	414	5,944

Seepage loss of Ives ditch (Left Branch Colorado Valley Pumping and Irrigation Company canal) at Yuma, Ariz.

[Distance, 4.26 miles.]

	Per cent.
March 21	10
April 18	17
May 9	14
May 23	18
July 2	19
July 17, a. m.	16
July 17, p. m.	18
Mean	16

REMARKS.—This is the loss between flumes No. 2 and No. 3. The water travels this distance in four and one-half hours. In each case the register records show a constant head, and meter gagings were made in flume No. 3 (the lower one). In addition to this, meter gagings were made in flume No. 2 on May 9, May 23, and July 17, a. m. For the remaining determinations the discharge at flume No. 2 was taken from the rating tables. In each case search was made along the ditch for leaks, and there was a very small loss from this source, which was estimated to be about 2 per cent, making the actual loss by seepage about 14 per cent. The ditch has not been cleaned for several years and is heavily silted, but it passes through a sandy part of the valley.

SOUTHERN CALIFORNIA DRAINAGE.

Under the head of southern California drainage have been included data concerning the streams of that part of the State south of San Joaquin basin. There are thus included the Mohave, which flows from the mountains north of San Bernardino into the Mohave Desert, a portion of the great Interior Basin, as well as those flowing toward the south or southwest, whose waters, in times of flood at least, reach the Pacific Ocean.

Arroyo Seco rises on the eastern slope of the Santa Lucia Mountains and flows east and empties into Salinas River at Soledad, Cal.

Santa Maria River drains the northern and western slopes of the San Rafael Mountains and enters the Pacific Ocean at Guadalupe about 25 miles below San Luis Obispo. Its principal tributary is Sisquoc River which joins the Santa Maria about 12 miles above the town of Santa Maria. No water is diverted from either of these streams for irrigation.

Santa Ynez River drains the northern slope of the Santa Ynez and the southern slope of the San Rafael Mountains, and enters the Pacific Ocean below Lompoc, Cal., about 75 miles above Santa Barbara. The principal tributary of Santa Ynez River is Mono Creek, which rises on the southern slope of the San Rafael Mountains. There are several good reservoir and dam sites on these streams.

Malibu Creek rises in the Santa Monica Mountains and enters the Pacific Ocean about 15 miles above the town of Santa Monica. Truimfo

Creek is the principal tributary of Malibu Creek. Several storage reservoir and dam sites exist on these streams.

The drainage basin of San Gabriel River lies on the southern slope of the Sierra Madre, being included in Los Angeles County, Cal. The various tributaries join the river before it enters its lowest canyon, whence it appears finally on the plain in the vicinity of Azusa. The seepage waters of this valley appear lower down in the river and finally enter the Pacific Ocean not far from the mouth of Los Angeles River. All of the surplus waters of this stream are now used for irrigation purposes, and it is only an occasional flood that passes the gaging station.

Santa Ana River has its source on the southern slope of the San Bernardino Mountains and flows southerly, appearing from its canyon 4 miles north of Redlands. Its waters are completely used in San Bernardino Valley. At the lower part of the valley the water appears again in the vicinity of Rincon, where the river passes through a comparatively narrow gorge; thence the general direction of the stream is southwesterly, emptying into the Pacific Ocean.

The headwaters of Mohave River have their source on the northern slopes of the San Bernardino Mountains. The river flows north, finally disappearing in the sands of the Mohave Desert.

San Luis Rey River rises on the western slope of the Coast Range and enters the Pacific Ocean at the town of Oceanside, San Diego County, Cal. The water is diverted at several points along this stream for irrigation.

The following pages give the results of data collected in southern California drainage during 1904:

ARROYO SECO NEAR SOLEDAD, CAL.

A gaging station was established by W. W. Cockins, jr., in December, 1900, at Foster's ranch, near Piney post-office, Cal. The high water of January, 1901, enlarged an old channel, and the gaging station was removed to Pettitt's ranch, 4 miles below. The purpose of establishing these gaging stations was to get the maximum flood discharge and the amount of water available for storage. The total area of the basin drained above Pettitt's ranch is 215 square miles. The observer is Mrs. Charles Pettitt.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Arroyo Seco near Soledad, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 22	F. R. S. Buttemer	5.52	24
February 5	F. W. Huber	6.08	150
February 13	W. B. Newhall	6.65	372
March 11	do	6.85	470
March 16	do	6.08	184
March 20	do	7.02	600
March 23	do	8.40	1,514
March 23	do	7.80	1,117
May 12	F. W. Huber	5.85	103
July 29	O. W. Peterson	5.20	1.1

Mean daily gage height, in feet, of Arroyo Seco near Soledad, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.45	5.50	6.10	6.60	6.10	5.60	5.35	5.15	4.55	5.40	5.50	5.50
2	5.50	5.50	6.00	6.50	6.00	5.60	5.35	5.20	4.50	5.40	5.50	5.45
3	5.50	5.50	5.90	6.35	5.95	5.60	5.35	5.15	4.50	5.35	5.50	5.45
4	5.50	5.45	5.90	6.30	5.90	5.60	5.35	5.15	4.40	5.35	5.50	5.45
5	5.50	6.10	5.85	6.20	5.90	5.60	5.35	5.20	4.35	5.35	5.50	5.45
6	5.50	5.80	5.80	6.15	5.85	5.55	5.30	5.20	4.30	5.35	5.50	5.45
7	5.50	5.75	5.75	6.10	5.85	5.55	5.30	5.15	4.30	5.40	5.45	5.45
8	5.50	5.70	5.70	6.10	5.80	5.50	5.30	5.15	4.25	5.40	5.45	5.45
9	5.50	5.70	5.70	6.00	5.80	5.50	5.30	5.10	4.15	6.10	5.45	5.45
10	5.50	5.70	8.15	6.00	5.80	5.50	5.30	5.10	4.10	6.20	5.45	5.50
11	5.50	5.70	7.00	6.00	5.80	5.50	5.30	5.10	4.00	7.00	5.45	5.45
12	5.45	6.90	6.55	5.90	5.80	5.50	5.30	5.10	4.00	6.10	5.45	5.45
13	5.45	6.60	6.30	5.90	5.75	5.45	5.30	5.10	4.00	5.85	5.45	5.45
14	5.45	6.00	6.20	5.90	5.70	5.45	5.30	5.05	3.95	5.75	5.40	5.45
15	5.45	5.90	6.20	5.90	5.70	5.45	5.30	5.05	3.95	5.70	5.50	5.45
16	5.45	8.40	6.10	5.85	5.70	5.45	5.30	5.05	3.90	5.65	5.55	5.45
17	5.45	6.45	6.15	5.80	5.70	5.45	5.30	5.05	3.85	5.60	5.50	5.45
18	5.50	6.10	6.85	8.00	5.70	5.45	5.30	5.00	3.80	5.60	5.50	5.45
19	5.60	5.90	6.50	6.80	5.70	5.45	5.30	5.00	3.75	5.55	5.50	5.45
20	5.60	6.00	7.00	6.45	5.70	5.40	5.30	5.00	3.70	5.55	5.50	5.45
21	5.55	5.80	6.70	6.30	5.70	5.40	5.25	5.00	3.70	5.55	5.50	5.45
22	5.55	5.75	6.50	6.20	5.70	5.40	5.25	5.00	3.70	5.50	5.50	5.45
23	5.50	5.70	8.50	6.10	5.70	5.40	5.25	4.95	4.05	5.50	5.50	5.45
24	5.50	5.70	7.75	6.10	5.65	5.40	5.25	4.90	5.80	5.50	5.45	5.45
25	5.50	5.75	7.10	6.10	5.65	5.40	5.20	4.90	5.60	5.50	5.45	5.75
26	5.50	5.80	6.80	6.10	5.60	5.40	5.20	4.85	5.80	5.50	5.50	5.55
27	5.50	6.80	6.55	6.10	5.60	5.40	5.20	4.80	5.60	5.50	5.50	5.50
28	5.50	6.60	6.50	6.10	5.60	5.35	5.20	4.80	5.50	5.50	5.50	5.50
29	5.50	6.25	7.35	6.05	5.60	5.35	5.20	4.70	5.50	5.50	5.50	5.50
30	5.50	.....	7.00	6.00	5.60	5.35	5.20	4.65	5.40	5.50	5.50	5.50
31	5.50	.....	6.80	.....	5.60	.....	5.20	4.60	.....	5.50	.....	7.40

Rating table for Arroyo Seco River near Soledad, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
5.00	0	6.30	230	7.60	930	8.90	1,960
5.10	0.5	6.40	270	7.70	1,000	9.00	2,050
5.20	1	6.50	310	7.80	1,070	9.20	2,250
5.30	3	6.60	360	7.90	1,140	9.40	2,460
5.40	9	6.70	410	8.00	1,210	9.60	2,680
5.50	18	6.80	460	8.10	1,290	9.80	2,900
5.60	30	6.90	510	8.20	1,370	10.00	3,140
5.70	48	7.00	560	8.30	1,450	10.20	3,380
5.80	71	7.10	620	8.40	1,530	10.40	3,620
5.90	100	7.20	680	8.50	1,610	10.60	3,880
6.00	130	7.30	740	8.60	1,690	10.80	4,140
6.10	160	7.40	800	8.70	1,780	11.00	4,410
6.20	195	7.50	860	8.80	1,870	11.50	5,150

Estimated monthly discharge of Arroya Seco near Soledad, Cal., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	30	14	18	1,107	0.08	0.09
February	510	14	181	10,411	.83	.90
March	1,610	48	394	24,226	1.82	2.10
April	1,210	71	214	12,734	.99	1.10
May	160	30	62	3,812	.29	.33
June	30	6	16	952	.07	.08
July	6	1	3	184	.01	.01
August	1	0	0	0	.00	.00
September	71	0	8	476	.04	.04
October	560	6	54	3,320	.25	.29
November	24	9	17	1,012	.08	.09
December	800	14	42	2,582	.19	.22
The year	1,610	0	84	60,816	.39	5.25

SANTA YNEZ RIVER NEAR SANTA BARBARA, CAL.

The original station at which measurements were made during the greater part of 1903 is located about 1 mile above the mouth of Mono Creek. It was established November 21, 1902, by W. B. Clapp, assisted by Howard Rankin. The gage is an inclined rod on the right bank. From January 25 to June 20, 1903, daily discharge measurements were made by means of a cable and car. The channel is straight for 400 feet above and for 600 feet below the cable. The current is sluggish at low stages. The right bank is low, but will overflow for only a short distance. There is an overflow channel on the left bank. The bed of the stream is composed of gravel and is permanent. The bench mark is a nail in the root of the poplar tree on the left bank to which the cable is attached. Its elevation is 7.18 feet above the zero of the gage. On November 1, 1903, a new station was established at the Gibraltar dam site by L. M. Hyde, assisted by H. W. Muzzall. It is located 5 miles below the original station and is below the mouth of Mono Creek. It is 9 miles above the San Marcus ranch and halfway between the old quicksilver mines. The gage is a 4 by 4 inch inclined timber, spiked to a cottonwood tree on the right bank. The tree is blazed above the gage rod for recording stages above the gage. Discharge measurements are made at high water by means of a cable 20 feet above the gage. Measurements can usually be made by wading. Weir measurements of the discharge were made daily from December 20 to 31, 1903. At the cable the initial point for soundings is a blaze at the base of the cottonwood tree on the right bank, to which the cable is attached. The channel is straight for 700 feet above and for 600 feet below the station. The right bank is low, but is not liable to overflow. The left bank rises abruptly about 20 feet beyond the alder tree to which the cable is attached. It is not liable to overflow. The bed of the stream is composed of sandy gravel, free from vegetation and bowlders. The cross section is regular, and is permanent. The current is swift. The bench mark is a cross on a bench of a ledge on the left bank, about 100 feet below the cable. Its elevation is 13.54 feet above the zero of the gage. The approximate elevation above sea level, as estimated from topographic maps, is 1,200 feet.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Santa Ynez River near Santa Barbara, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 18	R. L. North	2.20	4.32
January 19	do	2.07	1.77
February 5	do	2.28	3.44
February 6	do		3.27
February 7	do	2.15	2.35
February 8	do	2.15	2.27
February 9	do	2.10	2.17
February 10	do	2.08	1.74
February 16	do		6.89
February 17	do		4.49
February 18	do		2.74
February 19	do		2.53
February 20	do		2.11
February 27	do		45.00
February 28	do	3.00	96.00
February 29	do	2.32	16.20
March 1	do		7.00
March 2	do		5.28
March 3	do		4.33
March 4	do		2.70
March 5	do		2.95
March 6	do		2.88
March 7	do		2.43
March 8	do		2.33
March 9	do		2.60
March 10	do		2.35
March 11	do	3.08	135.00
March 12	do	2.44	27.00
March 13	do	2.36	16.40
March 14	do	2.32	11.90
March 15	do	2.28	10.20
March 19	do	2.20	7.24
March 20	do	2.20	6.96
March 21	do	2.18	6.41
March 23	do	3.88	442.00
March 24	do	2.82	70.00
March 25	do	2.68	49.00
March 26	do	2.52	30.00
March 27	do	2.46	26.00
March 28	do	2.43	24.00
March 29	do	2.47	26.00
March 30	do	2.45	25.00

Discharge measurements of Santa Ynez River near Santa Barbara, Cal., in 1904—Contd.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
March 31	R. L. North	2.42	23.00
April 1	do	2.37	16.30
April 2	do	2.35	14.50
April 3	do	2.33	14.20
April 4	do	2.31	11.20
April 5	do	2.32	12.40
April 6	do	2.27	10.10
April 7	do	2.26	9.64
April 8	do	2.25	8.87
April 12	do	2.20	6.80
April 13	do	2.20	6.87
April 14	do	2.19	5.32
April 15	do	2.19	5.24
April 16	do	2.21	5.93
April 17	do	2.20	5.61
April 18	do	2.20	5.64
April 19	do	3.03	101.00
April 20	do	2.83	74.00
April 21	do	2.52	30.00
April 22	do	2.47	25.00
April 24	do	2.39	17.10
April 25	do	2.37	16.60
April 27	do	2.47	24.00
April 28	do	2.46	23.00
April 29	do	2.43	21.00
April 30	do	2.43	20.00
May 2	do	2.38	17.20
May 5	do	2.32	11.40
May 6	do	2.29	10.50
May 7	do	2.28	10.20
May 8	do	2.23	7.90
May 9	do	2.23	8.05
May 10	do	2.22	7.69
May 14	do	2.19	5.89
May 15	do	2.19	6.40
May 16	do	2.15	4.28
May 17	do	2.13	4.05
May 18	do	2.16	4.43
May 19	do	2.12	3.60
May 21	do	2.12	3.29
May 22	do	2.12	3.34

Discharge measurements of Santa Ynez River near Santa Barbara, Cal., in 1904—Cont'd.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
May 23	R. L. North	2.11	3.13
May 24	do	2.11	3.19
May 25	do	2.16	4.43
May 26	do	2.14	4.41
May 27	do	2.12	3.32
May 30	do	2.09	2.99
May 31	do	2.09	3.12
June 1	do	2.09	2.94
June 2	do	2.07	2.60
June 3	do	2.06	2.50
June 4	do	2.05	2.28
June 5	do	2.05	2.28
June 6	do	2.03	2.06
June 10	do	2.01	.94

Mean daily gage height, in feet, of Santa Ynez River near Santa Barbara, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)		2.21	2.36	2.40	2.09				2.37	2.18	2.20
2			2.13	2.34	2.38	2.08				2.32	2.19	2.20
3			2.12	2.32	2.33	2.06				2.30	2.19	2.21
4			2.09	2.31	2.34	2.05				2.27	2.19	2.21
5		2.28	2.09	2.31	2.32	2.05				2.26	2.19	2.21
6		2.27	2.09	2.27	2.30	2.03				2.27	2.19	2.20
7		2.15	2.08	2.26	2.27	2.02				2.36	2.19	2.21
8		2.15	2.08	2.25	2.24	2.02				2.38	2.19	2.20
9		2.10	2.09	2.25	2.23	2.02				2.34	2.19	2.21
10		2.08	2.70	b2.23	2.22	2.01				2.32	2.19	2.21
11			2.70	2.21	2.21	2.00				2.29	2.19	2.21
12			2.44	2.20	2.20	2.00				2.26	2.19	2.21
13			2.36	2.20	2.20					2.26	2.19	2.21
14			2.30	2.20	2.19					2.24	2.20	2.20
15			2.28	2.19	2.20		(c)			2.22	2.20	2.20
16			2.40	2.26	2.20	2.16				2.21	2.20	2.20
17		2.32	2.23	2.20	2.13					2.20	2.20	2.21
18	2.20	2.24	2.21	2.20	2.15					2.20	2.20	2.21
19	2.07	2.22	2.20	3.08	2.12					2.20	2.20	2.21
20		2.21	2.20	2.78	2.13					2.20	2.22	2.21
21		2.05	2.18	2.56	2.12					2.19	2.22	2.21
22			2.18	2.47	2.12					2.19	2.21	2.21
23			3.89	2.41	2.12					2.18	2.21	2.21
24			2.83	2.39	2.11				3.00	2.18	2.21	2.21
25			2.66	2.37	2.15				8.20	2.18	2.21	2.21
26			2.52	2.40	2.14				3.00	2.18	2.21	2.21
27		3.12	2.45	2.47	2.12				2.60	2.18	2.21	2.21
28		3.00	2.44	2.42	2.10				2.50	2.18	2.21	2.21
29		2.30	2.47	2.46	b2.10				2.45	2.18	2.20	2.21
30			2.44	2.43	2.09				2.40	2.18	2.20	2.21
31			2.40		2.09					2.18		2.32

a Measured over weir: January 1-17, 20-31; February 1-4, 11-15, 22-26; June 13-30; July 1-14.
b Estimated.
c Dry: July 15 to September 23.

Rating table for Santa Ynez River near Santa Barbara, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.00	0.4	2.35	14.7	2.90	82	3.60	306
2.05	1.6	2.40	18.5	3.00	103	3.70	353
2.10	2.8	2.45	23	3.10	126	3.80	401
2.15	4.5	2.50	28	3.20	154	3.90	451
2.20	6.4	2.60	38	3.30	186	4.00	502
2.25	8.8	2.70	50	3.40	222		
2.30	11.6	2.80	65	3.50	263		

Estimated monthly discharge of Santa Ynez River near Santa Barbara, Cal., for 1904.

[Drainage area, 207 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January 7–31	6.4	0.5	0.9	45	0.004	0.004
February	131.0	.6	12.0	690	.058	.063
March	445.0	2.3	30.2	1,857	.146	.168
April	121.0	6.0	18.9	1,125	.091	.102
May	18.5	2.6	6.8	418	.033	.038
June	2.6	.1	.7	42	.003	.003
July	.1	.0	.034	2	.000	.000
August	.0	.0	.000	0	.000	.000
September	5,450	.0	193.	11,484	.832	1.040
October	17.0	5.6	8.7	535	.042	.048
November	7.4	5.6	6.4	381	.031	.035
December	12.8	6.4	7.0	430	.034	.039
The period				17,009		

MONO CREEK AT MONO DAM SITE, CALIFORNIA.

This station was established November 22, 1902, by W. B. Clapp, assisted by Howard Rankin. It is located about one-half mile above the junction of Mono Creek and Santa Ynez River, 15 miles above the San Marcus ranch and 17 miles by trail from Santa Barbara. The river at this point traverses Mono flat. The gage is an inclined timber hewn from a 4-inch sapling. It is spiked to a willow tree on the right bank. The tree has been blazed above the gage for use in recording flood stages above the gage rod. Discharge measurements are

made by means of a cable and by wading. The cable is located about 500 feet below the dam site and is just above the gage. The initial point for soundings is a blaze at the base of the tree to which the cable is fastened on the left bank. The channel is slightly curved for about 500 feet above and below the station. Both banks are high and are not liable to overflow. The bed of the stream is composed of sandy gravel, free from vegetation, and is not liable to shift. The bench mark is a standard United States Geological Survey bench-mark disk on a sandstone rock 100 feet south of the large oak tree on the left bank. Its elevation is 20.92 feet above the zero of the gage and 1,410 feet above sea level. The record of the discharge, kept by means of a weir, from November 1 to December 31, 1903, showed a constant discharge for this period of 0.05 second-foot.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Mono Creek at Mono dam site, California, in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
February 28	R. L. North	1.89	30.0
February 29	do	1.41	3.5
March 11	do	1.90	32.0
March 12	do	1.48	8.0
March 13	do	1.35	2.6
March 14	do	1.33	2.3
March 25	do	1.71	18.2
March 27	do	1.52	8.2
March 29	do	1.48	7.9
April 1	do	1.52	8.1
April 3	do	1.43	4.1
April 19	do	1.95	34.0
April 20	do	1.77	19.4
April 21	do	1.64	9.7
April 24	do	1.45	5.4
April 25	do	1.42	4.0
April 26	do	1.63	8.9
April 27	do	1.63	8.8
April 29	do	1.62	8.2
May 1	do	1.46	6.4
May 5	do	1.43	4.2
May 7	do	1.32	2.1
May 9	do	1.32	2.0
May 11	do	1.32	2.0

Mean daily gage height, in feet, of Mono Creek at Mono dam site, California, for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	(a)	.....	.....	1.52	1.46	(1.29)	(b)
2	.....	.....	.....	(1.47)	(1.47)	1.29	.....
3	.....	.....	.....	1.43	(1.48)	1.29	.....
4	.....	.....	.....	1.38	1.49	(1.29)	.....
5	.....	.....	.....	1.38	1.43	1.29	.....
6	.....	.....	.....	(1.38)	(1.37)	(1.29)	.....
7	.....	.....	.....	1.37	1.32	1.29	.....
8	.....	.....	.....	1.35	(1.32)	1.28	.....
9	.....	.....	.....	(1.35)	1.32	1.25	.....
10	.....	.....	.....	(1.35)	(1.32)	1.28	.....
11	.....	.....	1.90	(1.35)	1.32	1.28	.....
12	.....	.....	1.48	1.35	1.39	1.26	.....
13	.....	.....	1.35	1.35	(1.38)	1.26	.....
14	.....	.....	1.33	1.35	(1.38)	1.25	.....
15	.....	.....	(1.33)	1.35	1.37	1.25	.....
16	.....	.....	(1.32)	(1.35)	(1.37)	1.25	.....
17	.....	.....	(1.31)	1.36	1.36	1.25	.....
18	.....	.....	(1.30)	(1.36)	(1.35)	(1.25)	.....
19	.....	.....	.....	1.95	1.34	1.25	.....
20	.....	.....	.....	1.77	(1.34)	1.25	.....
21	.....	.....	.....	1.64	(1.35)	1.25	.....
22	.....	.....	.....	1.58	1.35	1.25	.....
23	.....	.....	.....	1.52	(1.34)	1.25	.....
24	.....	.....	2.21	1.45	1.33	1.25	.....
25	.....	.....	1.71	1.42	(1.34)	(1.25)	.....
26	.....	.....	(1.60)	1.63	1.35	(1.24)	.....
27	.....	3.06	1.52	1.63	1.34	(1.23)	.....
28	.....	1.89	(1.50)	(1.63)	(1.33)	1.22	.....
29	.....	1.41	1.48	1.62	(1.32)	1.21	.....
30	.....	.....	(1.50)	(1.60)	(1.31)	(1.21)	.....
31	.....	.....	1.52	.....	1.30	.....	.....

[a] Where gage heights are not given measurements were made over weir.
[b] Record stopped for the summer.

Gage heights in parenthesis are estimated.

Rating table for Mono Creek at Mono dam site, California, from January 1 to June 30, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.10	0.0	1.50	6.6	1.90	31	2.60	162
1.15	0.2	1.55	8.6	1.95	35	2.70	188
1.20	0.5	1.60	11.2	2.00	40	2.80	214
1.25	1.0	1.65	13.8	2.10	54	2.90	242
1.30	1.5	1.70	16.8	2.20	73	3.00	270
1.35	2.4	1.75	20	2.30	93	3.10	300
1.40	3.5	1.80	23.5	2.40	114	3.20	330
1.45	5.0	1.85	27	2.50	137		

Estimated monthly discharge of Mono Creek at Mono dam site, California, for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	0.07	0.04	0.04	2	T.	T.
February	285	.03	11	633	0.09	0.10
March	76	.06	6.3	387	.05	.06
April	35	2.4	7.1	422	.06	.07
May	6.3	1.5	2.8	172	.02	.02
June	1.4	.6	1.1	65	.01	.01
The period				1,681		

MALIBU AND TRIUMFO CREEKS NEAR CALABASAS, CAL.

These stations were established at Chapman's ranch November 29, 1901, by S. G. Bennett. They are 40 miles from Los Angeles by wagon road and 8 miles southwest of Calabasas. Malibu Creek is formed by Triumfo and Las Virgines creeks, and is a short stream flowing through the Santa Monica Mountains and discharging into the Pacific Ocean about 15 miles above the city of Santa Monica, Cal. Sites for good storage reservoirs exist in both of these drainage basins, one on Malibu Creek a short distance below its gaging station, and one on Triumfo Creek above its gaging station. The water from these streams could be used for irrigation on the valuable land lying along the base of the mountains between the city of Los Angeles and Santa Monica, where it is greatly needed.

The channels of both streams are poor and subject to change during high water. They are located, however, at the only point where an observer could be secured. The excessive cost of visiting these stations has made it impossible to obtain as many meter measurements as desired, but the observer is instructed to take float velocities during floods at various gage heights, and these data, with cross sections and grade of stream, are used in addition to meter measurements for computing discharges for use in constructing rating curves and tables. The gage rods for both stations are vertical 2 by 6 inch wooden rods graduated to feet and tenths.

The gaging station on Malibu Creek is located about one-fourth mile below the mouth of Las Virgines Creek. The channel above the station is straight for about 600 feet, and below the station is curved for about 300 feet, and the water is swift. Both banks are high. The right bank is rocky, and the bed of the stream is composed of rock and gravel. The initial point for soundings is on the right

bank. The bench mark is a cross on a small projection on a rock bluff about 10 feet southwest of the gage rod. The assumed elevation of the bench mark is 530.00 feet. The zero of the gage rod is 524.57 feet elevation.

The gaging station on Triumfo Creek is about one-half mile above the mouth of Las Virgines Creek. The channel is straight for about 400 feet above and 800 feet below the station, and the water is swift. Both banks are high and rocky. The bed of the stream is composed of gravel and sand and is shifting. The initial point for soundings is on the right bank. The bench mark is a cross on a point of rock 3.5 feet above the bed of the creek. The assumed elevation is 550.00 feet. The zero of the gage rod is 545.47 feet elevation. The observer for both stations is J. G. Chapman.

The observations at these stations during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Mean daily gage height, in feet, of Malibu Creek near Calabasas, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Oct.	Nov.	Dec.
1	1.20	1.20	1.20	1.20	1.15	1.05	1.05	.....	1.00	1.15
2	1.20	1.20	1.20	1.20	1.15	1.05	1.05	.....	1.00	1.15
3	1.20	1.20	1.20	1.20	1.15	1.05	(a)	.....	1.00	1.20
4	1.20	1.20	1.20	1.20	1.15	1.05	.....	.....	1.00	1.20
5	1.20	1.20	1.20	1.10	1.15	1.05	.....	.....	1.00	1.20
6	1.20	1.20	1.20	1.10	1.15	1.05	.....	.....	1.00	1.20
7	1.20	1.20	1.20	1.10	1.15	1.05	.....	.....	1.00	1.20
8	1.20	1.20	1.20	1.05	1.15	1.05	.....	.....	1.00	1.20
9	1.20	1.20	1.20	1.00	1.15	1.05	.....	.....	1.00	1.20
10	1.20	1.20	1.60	1.00	1.15	1.05	.....	.....	1.00	1.20
11	1.20	1.20	1.45	1.05	1.10	1.05	.....	.....	1.00	1.20
12	1.20	1.20	1.25	1.05	1.10	1.05	.....	.....	1.00	1.20
13	1.20	1.20	1.15	1.05	1.10	1.05	.....	.....	1.00	1.20
14	1.20	1.20	1.15	1.05	1.05	1.05	.....	.....	1.00	1.20
15	1.20	1.20	1.15	1.05	1.05	1.05	.....	1.00	1.00	1.20
16	1.20	1.30	1.15	1.05	1.05	1.05	.....	1.00	1.00	1.20
17	1.20	1.25	1.15	1.05	1.05	1.05	.....	1.00	1.00	1.20
18	1.20	1.25	1.15	1.05	1.05	1.05	.....	1.00	1.00	1.20
19	1.20	1.20	1.15	1.15	1.05	1.05	.....	1.00	1.00	1.20
20	1.20	1.20	1.15	1.15	1.05	1.05	.....	1.00	1.00	1.20
21	1.20	1.20	1.15	1.15	1.00	1.05	.....	1.00	1.00	1.20
22	1.20	1.20	1.15	1.15	1.00	1.05	.....	1.00	1.00	1.20
23	1.20	1.20	1.50	1.15	1.00	1.05	.....	1.00	1.00	1.20
24	1.20	1.20	1.25	1.15	1.00	1.05	.....	1.00	1.00	1.20
25	1.20	1.20	1.20	1.15	1.00	1.05	.....	1.00	1.00	1.20
26	1.20	1.20	1.20	1.15	1.00	1.05	.....	1.00	1.00	1.20
27	1.20	1.25	1.20	1.15	1.00	1.05	.....	1.00	1.10	1.20
28	1.20	1.20	1.20	1.15	1.05	1.05	.....	1.00	1.10	1.20
29	1.20	1.20	1.20	1.15	1.05	1.05	.....	1.00	1.10	1.20
30	1.20	.....	1.20	1.15	1.05	1.05	.....	1.00	1.15	1.20
31	1.20	.....	1.20	.....	1.05	.....	.....	1.00	.....	1.20

a July 3, record stopped for summer.

Rating table for Malibu Creek near Calabasas, Cal., from March 31, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.00	1	1.70	44	2.40	265	3.10	720
1.10	2	1.80	57	2.50	330	3.20	785
1.20	5	1.90	72	2.60	395	3.30	850
1.30	10	2.00	95	2.70	460	3.40	915
1.40	16	2.10	128	2.80	525	3.50	980
1.50	24	2.20	165	2.90	590		
1.60	33	2.30	210	3.00	655		

Estimated monthly discharge of Malibu Creek near Calabasas, Cal., for 1904.

[Drainage area, 97 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	5	5	5.0	307	0.05	0.06
February	10	5	5.5	316	.06	.06
March	33	4	6.9	424	.07	.08
April	5	1	3.0	179	.03	.03
May	4	1	2.2	135	.02	.02
June	1.5	1.5	1.5	89	.02	.02
October 15–31	1	1	1.0	[a] 61	.01	.01
November	4	1	1.2	71	.01	.01
December	5	4	4.9	301	.05	.06
The period				1,883		

[a] Mean for 17 days taken as mean for month.

Mean daily gage height, in feet, of Triumfo Creek near Calabasas, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.
1	0.45	0.45	0.45	0.45	0.40
2	.45	.45	.45	.40	.40
3	.45	.45	.45	.40	.40
4	.45	.45	.45	.40	.40
5	.45	.55	.45	.40	.40
6	.45	.50	.45	.40	.40
7	.45	.50	.45	.40	.40
8	.45	.45	.40	.35	.40
9	.45	.45	.40	.30	.35
10	.45	.45	1.00	.30	.35
11	.45	.45	.80	.30	.30
12	.45	.45	.50	.30	.25
13	.45	.45	.45	.30	.20
14	.45	.45	.45	.35	.15
15	.45	.55	.45	.40	.15
16	.45	.65	.45	.40	.10
17	.45	.60	.45	.45	.10
18	.45	.60	.45	.45	.10
19	.45	.55	.45	.50	.10
20	.45	.50	.45	.40	.10
21	.45	.50	.45	.40	[a].00
22	.45	.50	.45	.40	.....
23	.45	.50	.90	.40	.....
24	.45	.50	.60	.40	.....
25	.45	.50	.55	.40	.....
26	.45	.50	.50	.40	.....
27	.45	.60	.50	.40	.....
28	.45	.50	.50	.40	.....
29	.45	.50	.45	.40	.....
30	.45	.....	.45	.40	.....
31	.45	.....	.45	.....	.....

[a] Stream entirely dry for remainder of the year.

Rating table for Triumfo Creek near Calabasas, Cal., from March 31, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.30	0.5	0.9	19	1.50	101	2.10	373
.40	2	1.00	26	1.60	129	2.20	450
.50	4	1.10	35	1.70	162	2.30	550
.60	6	1.20	46	1.80	200	2.40	670
.70	9	1.30	60	1.90	250		
.80	14	1.40	78	2.00	305		

Estimated monthly discharge of Triumfo Creek near Calabasas, Cal., for 1904.

[Drainage area, 72 square miles.]

Month.	Discharge in second-feet.			Run-off.		
	Maximum.	Minimum.	Mean.	Total in acre-feet.	Second-feet per square mile.	Depth in inches.
January	3	3	3	184	0.04	0.05
February	8	3	4.1	236	.06	.06
March	26	2	4.8	295	.07	.08
April	4	0.5	1.8	107	.02	.02
May	2	0	.6	37	.01	.01
The period				859		

SAN GABRIEL RIVER AND CANALS NEAR AZUSA, CAL.

Owing to the numerous diversions it has been difficult to obtain accurate discharge measurements at Azusa; but during 1898 the San Gabriel Electric Company completed its system, and measurements are now obtained with greater ease and hence with greater accuracy. The headworks of this company are located about 6 miles above the mouth of the canyon; the water is carried along the left side by a series of tunnels and conduits, and a head of 400 feet is obtained where the electric power is generated. Weirs are placed on the conduit of the electric company, and the water is measured at this point. The capacity of the conduit is 80 second-feet.

The cable and gage are located about 1 mile from Azusa. During the season of low water for a period of from six to eight months the canals above the station divert the entire flow, and there is no running water at the station. The gage is a vertical 4 by 4 inch timber. Discharge measurements are made by means of a cable. The channel is straight for 150 feet above and for 500 feet below the cable, and has a width of 280 feet at high water. At low stages there are two channels having different elevations, and accurate measurements are difficult to obtain. The bed of the stream is composed of cobblestones and bowlders, and the current is swift.

The total flow of the river is obtained by adding the daily discharge for the river to the figures for the corresponding dates for the canals. The observer is H. F. Parkinson.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurement of San Gabriel River and canals near Azusa, Cal., for 1904.

Date.	Hydrographer.	Gage height.	Discharge.	Remarks.
		Feet.	*Second-feet.*	
March 18	E. C. Murphy	00	00	River.
	W. B. Clapp	Weir.	43	Canal.
			43	Total.
April 8	W. B. Clapp	1.30	14	River.
		Weir.	68	Canal.
			82	Total.
April 19	W. B. Clapp	1.58	38	River.
	R. P. Webb	Weir.	66	Canal.
			104	Total.

Mean daily gage height, in feet, of San Gabriel River near Azusa, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.
1	[a] 0.00	0.00	1.30	1.70	1.50
2	.00	.00	1.10	1.60	1.50
3	.00	.00	[a] .00	1.55	1.45
4	.00	.00	.00	1.50	1.40
5	.00	.00	.00	1.40	1.40
6	.00	.00	.00	1.40	1.35
7	.00	.00	.00	1.35	1.30
8	.00	.00	.00	1.30	1.25
9	.00	.00	.00	1.20	1.20
10	.00	.00	.00	1.10	1.15
11	.00	.00	1.85	.90	1.10
12	.00	.00	1.20	.75	1.00
13	.00	.00	.90	[a] .00	.80
14	.00	.00	[a] .00	.00	[b] .00
15	.00	.00	.00	.00	.00
16	.00	.00	.00	.00	.00
17	.00	.00	.00	.00	.00
18	.00	.00	.00	.00	.00
19	.00	.00	.00	1.65	.00
20	.00	.00	.00	1.70	.00
21	.00	.00	.00	1.50	.00
22	.00	.00	.00	1.40	.00
23	.00	.00	4.15	1.35	.00
24	.00	.00	2.40	1.30	.00
25	.00	.00	2.00	1.20	.00
26	.00	.00	1.80	1.50	.00
27	.00	.00	1.70	1.45	.00
28	.00	3.20	1.70	1.40	.00
29	.00	1.70	2.00	1.40	.00
30	.00	.....	1.90	1.40	.00
31	.00	.....	1.80	.....	.00

[a] River dry at rod: Jan. 1-Feb. 27; Mar. 3-10; Mar. 14-22; Apr. 13-18.
[b] River dry at rod remainder of the year. (See canals.)

Mean daily discharge, in second-feet, of San Gabriel canals near Azusa, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	24.0	23.0	47.0	66.0	67.0	38.0	18.0	10.0	11.0	10.5	12.5	15.0
2	24.0	23.5	51.5	66.0	67.0	36.5	17.5	9.5	10.8	9.0	12.5	15.3
3	24.0	23.5	47.0	66.0	67.0	35.5	17.0	10.0	10.5	10.0	12.5	15.3
4	24.0	23.5	42.0	66.0	67.0	32.5	17.0	10.0	10.5	10.0	12.5	15.3
5	24.0	59.0	40.0	66.0	67.0	32.0	16.5	10.0	10.0	11.0	12.5	15.3
6	23.5	37.0	38.0	66.0	67.0	31.0	16.0	10.0	9.0	12.0	12.5	14.7
7	23.3	31.5	37.5	66.0	67.0	30.0	16.0	12.0	8.5	12.5	12.5	15.2
8	24.0	31.0	35.5	68.0	67.0	30.0	15.7	12.7	7.5	15.0	12.0	15.3
9	24.5	30.0	35.0	68.0	67.0	29.0	15.5	11.5	8.5	15.5	11.0	16.0
10	24.5	30.0	35.5	68.0	67.0	28.0	15.0	11.5	9.5	15.5	11.0	16.0
11	24.5	30.0	60.0	68.0	67.0	26.5	13.8	11.0	9.5	15.5	11.5	16.0
12	24.0	28.0	60.0	68.0	66.0	25.2	14.0	10.0	9.5	14.5	12.0	16.0
13	24.0	28.0	56.0	66.0	65.0	25.2	14.3	29.0	12.5	13.5	12.5	16.0
14	23.5	28.0	51.0	64.0	64.0	23.0	15.5	15.0	11.5	13.0	12.5	16.0
15	23.5	28.0	49.0	64.0	61.0	24.0	15.0	14.5	11.0	13.5	12.5	16.0
16	23.5	40.0	46.0	61.0	59.0	23.0	15.0	14.0	10.0	13.5	12.5	16.0
17	23.5	41.0	44.5	58.0	56.0	22.5	14.0	14.0	11.0	12.0	12.6	16.0
18	28.2	38.0	42.6	57.0	55.0	22.0	14.0	13.7	12.0	11.5	13.3	16.0
19	27.4	34.5	41.5	66.0	53.0	22.0	13.0	13.7	12.0	10.5	13.0	16.0
20	27.4	33.0	50.0	66.0	51.0	22.0	12.5	13.7	12.0	9.5	13.5	15.5
21	25.5	31.4	48.0	66.0	49.0	25.0	11.8	13.5	12.0	10.0	13.5	15.7
22	25.2	30.8	46.0	66.0	48.0	23.0	12.0	15.0	12.0	10.5	13.5	16.3
23	24.6	30.0	62.0	67.0	44.5	23.0	12.0	15.0	11.0	11.0	13.5	16.8
24	24.5	29.5	62.0	67.0	44.5	23.0	11.1	14.5	12.0	11.0	13.0	17.0
25	24.5	29.5	62.0	67.0	46.0	22.0	11.0	14.5	12.7	11.0	13.0	16.7
26	24.5	29.5	62.0	67.0	51.0	19.0	11.0	13.0	13.5	11.5	13.5	16.0
27	24.0	30.0	62.0	67.0	46.5	18.5	12.0	12.5	12.5	11.5	14.0	16.7
28	23.5	00.0	62.0	67.0	40.0	18.5	11.5	11.5	12.0	11.5	14.0	16.5
29	23.5	38.0	66.0	67.0	40.0	18.5	12.0	11.3	10.5	12.0	14.5	16.0
30	23.5	.....	66.0	67.0	37.0	17.5	12.0	11.0	10.5	12.5	14.5	16.0
31	23.0	.....	66.0	.....	38.0	.....	11.0	11.0	.....	12.5	.....	48.0

Rating table for San Gabriel River near Azusa, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.60	1	2.00	92	3.40	535	5.60	2,855
.70	2	2.10	107	3.50	590	5.80	3,180
.80	4	2.20	125	3.60	652	6.00	3,525
.90	7	2.30	144	3.70	720	6.20	3,890
1.00	10	2.40	164	3.80	792	6.40	4,275
1.10	13	2.50	186	3.90	867	6.60	4,683
1.20	18	2.60	211	4.00	945	6.80	5,120
1.30	24	2.70	240	4.20	1,110	7.00	5,580
1.40	30	2.80	273	4.40	1,295	7.20	6,072
1.50	37	2.90	310	4.60	1,500	7.40	6,610
1.60	45	3.00	350	4.80	1,728	7.60	7,205
1.70	54	3.10	393	5.00	1,980	7.80	7,870
1.80	65	3.20	438	5.20	2,254	8.00	8,600
1.90	78	3.30	485	5.40	2,549		

Estimated monthly discharge of San Gabriel River and canals near Azusa, Cal., for 1904.[a]

[Drainage area, 222 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	28.2	23	24.4	1,500	0.11	0.13
February	438	23	47.7	2,744	.21	.23
March	1,130	35	110.8	6,813	.50	.58
April	120	57	89.7	5,337	.40	.45
May	104	37	66.5	4,089	.30	.35
June	38	17.5	25.5	1,517	.11	.12
July	18	11.0	14.0	861	.06	.07
August	29	9.5	12.9	793	.06	.07
September	13.5	7.5	10.8	643	.05	.06
October	15.5	9.0	12.0	738	.05	.06
November	14.5	11.0	12.8	762	.06	.07
December	48	14.7	16.9	1,039	.08	.09
The year	1,130	7.5	37	26,836	.17	2.28

[a] Includes water in canals.

SAN LUIS REY RIVER NEAR PALA, CAL.

This station was established October 9, 1903, by W. B. Clapp. It is located at Sickler's mill, 4 miles above Pala, Cal. It is reached by driving from Fallbrook or Escondido, stations on the Southern California Railway, 18 and 25 miles distant, respectively. The gage is an inclined 2-by 4 inch rod, graduated to feet and tenths, spiked to tree stumps and stakes at the left bank of the river. It is read once each day by M. M. Sickler. Discharge measurements are usually made by wading. During high water they are made from a car suspended from a ¾-inch galvanized iron wire cable stretched across the river at the gage. The initial point for soundings is the base of the oak tree to which the left end of the cable is fastened. The channel is straight for about 800 feet above and for 2,000 feet below the station. The grade of the stream is 0.60 feet in 100 feet. The current is swift. The right bank rises abruptly about 15 feet beyond the oak tree to which the cable is fastened and is not liable to overflow. The left bank is low, but is not liable to overflow. It was once a portion of the river channel, but is now well above high-water marks. The bed of the stream is rocky in portions of the flood channel, but the low-water channel is clear of rocks. There is a considerable growth of small timber in the channel, but this has been cleared the entire width

of the cross section for a distance of 100 feet above and 50 feet below the station. This timber growth is not permanent, being washed out by floods every few years. The bench mark is a United States standard bronze-capped iron post set flush with the ground on the right bank of the river and the north side of the wagon road, and about 50 feet west from the line of the cable prolonged. Its elevation is 557 feet above mean sea level, and 26.98 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Mean daily gage height, in feet, of San Luis Rey River near Pala, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Sept.	Oct.	Nov.	Dec.
1	1.74	1.74	1.87	2.32	1.80	1.68	.....	.....	1.40	1.45
2	1.74	1.74	1.84	2.28	1.90	1.68	.....	.....	1.40	1.55
3	1.74	1.74	1.82	2.24	1.85	1.68	.....	.....	1.41	1.55
4	1.74	1.74	1.79	2.20	1.80	1.68	.....	.....	1.40	1.55
5	1.74	1.86	1.77	2.18	1.78	1.69	.....	.....	1.40	1.55
6	1.74	1.80	1.77	2.10	1.75	1.69	.....	.....	1.40	1.55
7	1.74	1.80	1.77	2.08	1.75	1.69	.....	.....	1.39	1.55
8	1.74	1.80	1.77	2.05	1.74	1.68	.....	.....	1.39	1.55
9	1.74	1.79	1.77	2.05	1.74	1.67	2.03	.....	1.39	1.55
10	1.74	1.78	1.77	2.05	1.73	1.67	.....	1.70	1.39	1.55
11	1.74	1.78	1.95	2.04	1.73	1.67	.....	1.52	1.39	1.55
12	1.74	1.78	1.82	2.00	1.72	1.66	.....	1.40	1.39	1.55
13	1.74	1.78	1.80	1.95	1.72	1.66	.....	1.40	1.39	1.50
14	1.74	1.78	1.77	1.90	1.72	1.65	.....	1.40	1.39	1.45
15	1.74	1.78	1.75	1.85	1.71	1.65	.....	1.40	1.39	1.40
16	1.74	1.80	1.75	1.80	1.71	1.64	.....	1.41	1.40	1.40
17	1.74	1.82	1.75	1.78	1.71	1.64	.....	1.40	1.41	1.40
18	1.75	1.80	1.75	1.78	1.71	1.65	.....	1.40	1.42	1.40
19	1.75	1.80	1.77	1.78	1.71	1.65	.....	1.40	1.43	1.40
20	1.75	1.80	1.82	1.85	1.71	1.66	.....	1.40	1.45	1.40
21	1.75	1.80	1.77	1.85	1.71	1.66	.....	1.40	1.45	1.40
22	1.75	1.79	1.77	1.80	1.71	1.65	.....	1.41	1.45	1.40
23	1.75	1.79	3.50	1.80	1.71	1.65	.....	1.40	1.45	1.45
24	1.75	1.78	2.61	1.80	1.71	1.65	.....	1.39	1.45	1.45
25	1.74	1.78	2.31	1.79	1.71	1.65	.....	1.39	1.45	1.45
26	1.74	1.78	2.22	1.82	1.70	1.66	.....	1.40	1.45	1.45
27	1.74	1.78	2.18	1.82	1.70	1.65	.....	1.39	1.45	1.45
28	1.74	1.78	2.10	1.80	1.70	1.65	.....	1.40	1.45	1.45
29	1.74	1.88	2.52	1.80	1.69	1.66	.....	1.41	1.45	1.45
30	1.74	.....	2.50	1.80	1.69	[a] 1.65	.....	1.41	1.45	1.45
31	1.74	.....	2.50	.....	1.68	.....	.....	1.40	.....	1.50

[a] Gage observations discontinued until October 10.

SANTA ANA RIVER NEAR MENTONE, CAL.

This station was established in June, 1896. It is located 5 miles northeast of Mentone, Cal., three-fourths of a mile below the head works of the Mentone Power Company's canal, and opposite the warm springs in the canyon.

The Edison Electric Company diverts the greater portion of the water of Santa Ana River above the gaging station, but also returns all of it above the station. They, however, allow only limited portions of the water to pass out of their conduits during certain hours of the day, holding back the water for the purpose of obtaining additional power when the greatest demand exists.

The Mentone Power Company's canal, formerly called the Santa Ana canal, diverts water above the station, all of which is returned below the point of measurement. During the low-water season the entire flow of the river is diverted by the canals. The gage is an inclined 4 by 6 inch timber fastened to a large bowlder on the left bank. The channel was deepened by a flood March 31, 1903, and the gage was accordingly lowered to reach low-water stages June 30, 1903. The gage is read once each day by A. Laird. Discharge measurements are made by means of a cable and car, 100 feet below the gage. The initial point for soundings is the bench-mark spike set in the north side of a cottonwood tree on the left bank, 30 feet west of the tree to which the cable is fastened. The channel is straight for 100 feet above and below the station, and has a width of 22 feet at low and 125 feet at high stages. The current is swift at all stages. At flood stages the velocity is so high that measurements can be made only by means of floats. The right bank is low and is liable to overflow at flood stages for about 100 feet. The left bank is low, but is not liable to overflow. Both banks are overgrown with alders. The bed of the stream is composed of firm sand and small bowlders; it is subject to considerable change during flood stages. The bench mark, which is also used as the initial point for soundings, is a spike in the north side of the cottonwood tree on the left bank, 30 feet west of the tree to which the cable is fastened. Its elevation is 7.29 feet above the zero of the gage.

The observations of this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Santa Ana River near Mentone, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.	Remarks.
		Feet.	*Second-feet.*	
January 29	W. B. Clapp	Weir	26	Mentone Power Co.'s canal; total for river.
March 4	do	1.15	21	River.
		Weir.	12	Mentone Power Co.'s canal.
			33	Total for river.
March 12	do	1.25	26	River.
		Weir.	17	Mentone Power Co.'s canal.
			43	Total for river.
March 22	W. B. Clapp E. C. Murphy	1.10	20	River.
		Weir.	19	Mentone Power Co.'s canal.
			39	Total for river.
April 20	W. B. Clapp	1.65	49	River.
		Weir.	19	Mentone Power Co.'s canal.
			68	Total for river.
April 21	do	1.38	24	River.
		Weir.	35	Mentone Power Co.'s canal.
			59	Total for river.
May 14	do	1.25	16	River.
		Weir.	20	Mentone Power Co.'s canal.
			36	Total for river.
May 28	do	1.40	21	River.
		Weir.	18	Mentone Power Co.'s canal.
			39	Total for river.
June 29	do	1.45	24	River.
		Weir.	22	Mentone Power Co.'s canal.
			46	Total for river.
September 21	do		2	River.
			56	Mentone Power Co.'s canal.
			58	Total for river.
November 11	E. C. La Rue	.83	1	River.
		Weir.	18	Mentone Power Co.'s canal.
			19	Total for river.

Rating table for Santa Ana River near Mentone, Cal., from January 1 to March 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.35	0	0.80	10	1.50	43	2.40	144
.40	1	.85	11	1.60	51	2.50	161
.45	2	.90	13	1.70	60	2.60	179
.50	3	.95	15	1.80	69	2.70	199
.55	4	1.00	16	1.90	79	2.80	221
.60	5	1.10	20	2.00	91	2.90	245
.65	6	1.20	24	2.10	102	3.00	280
.70	7	1.30	30	2.20	114		
.75	9	1.40	36	2.30	129		

Rating table for Santa Ana River near Mentone, Cal., from April 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.80	1	1.10	9	1.60	37	2.10	93
.85	1.5	1.20	12	1.70	47	2.20	106
.90	2	1.30	17	1.80	57	2.30	122
.95	3	1.40	23	1.90	68		
1.00	5	1.50	29	2.00	80		

Two tables were necessary on account of change in channel on April 1, 1904.

Estimated monthly discharge of Santa Ana River[a] near Mentone, Cal., for 1904.[b]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	28	24	26	1,599	0.14	0.16
February	94	26	33	1,898	.18	.19
March	280	28	64	3,935	.35	.40
April	106	36	53	3,154	.29	.32
May	48	34	41	2,521	.23	.27
June	50	37	44	2,618	.24	.27
July	52	37	45	2,767	.25	.29
August	56	35	46	2,828	.25	.29
September	58	40	50	2,975	.27	.30
October	56	22	48	2,951	.26	.30
November	22	17.7	20	1,190	.11	.12
December	23	18.4	20	1,230	.11	.13
The year	280	17.7	41	29,666	.22	3.04

[a] Estimated monthly discharge includes Mentone Power Company's canal.
[b] River received water from Bear Valley reservoir to October 31, 1904.

SANTA MARIA RIVER NEAR SANTA MARIA, CAL.

This station was established October 22, 1903, by W. B. Clapp. It is located near the ranch house on Dutard's ranch, 21 miles above Santa Maria, Cal., a station on the Pacific Coast Railway. It is reached by driving from Santa Maria. The gage is an inclined 2 by 6 inch timber graduated to feet and tenths and fastened to a rock ledge at the right bank. It is read once each day by Joseph A. Thompson. At low and medium water, discharge measurements are made with meter by wading. During high water, velocities are measured by means of floats. For this purpose two wires are stretched across the stream 254 feet apart. The measuring stations are marked on each wire. The initial points for soundings are blazes on the poplar trees on the left bank, to which the wires are attached. The channel is slightly curved for 300 feet above, and curved for 1,000 feet below the station. The water is swift at medium and flood stages. The rise in the channel above the upper wire is 0.40 foot in 100 feet, and below the upper wire it is 0.57 foot in 100 feet. The right bank is high and rocky, and not liable to overflow. The left bank is low, covered with scattering poplar trees, but not liable to overflow. The bed of the stream is composed of sand and gravel. A portion of the bed is covered with a light growth of low brush. The channel is not liable to much change. The bench mark is a spike driven, near the ground, into the south side of the poplar tree to which the upper wire is fastened on the left bank of the stream. Its elevation is 9.65 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Santa Maria River near Santa Maria, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
February 18	W. B. Clapp	2.65	15.5
March 12	J. A. Thompson	3.60	[a] 220
March 24	do	4.00	[a] 499

[a] Float measurements.

Mean daily gage height, in feet, of Santa Maria River near Santa Maria, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Oct.	Nov.	Dec.
1	2.30	2.38	2.60	2.63	2.20	1.80	3.95	2.50	2.53
2	2.30	2.38	2.57	2.60	2.20	1.80	3.50	2.50	2.55
3	2.30	2.38	2.55	2.45	2.20	1.80	3.50	2.50	2.57
4	2.30	2.38	2.50	2.30	2.18	1.80	3.50	2.50	2.60
5	2.30	2.50	2.45	2.27	2.15	1.80	3.50	2.51	2.60
6	2.30	2.50	2.40	2.20	2.15	1.80	3.50	2.51	2.62
7	2.30	2.50	2.38	2.15	2.15	1.80	3.65	2.50	2.62
8	2.30	2.50	2.36	2.11	2.15	1.80	3.80	2.49	2.63
9	2.30	2.45	2.35	2.05	2.10	1.80	3.83	2.49	2.61
10	2.30	2.43	2.35	2.05	2.05	1.80	3.85	2.49	2.60
11	2.30	2.41	2.70	2.05	2.00	1.80	3.90	2.51	2.63
12	2.30	2.41	3.60	2.05	2.00	1.80	3.50	2.54	2.65
13	2.30	2.50	3.00	2.05	2.00	1.80	3.00	2.55	2.66
14	2.30	2.40	3.40	2.05	1.90	1.80	2.50	2.55	2.68
15	2.30	2.48	2.80	2.05	1.90	1.80	2.49	2.54	2.68
16	2.30	3.10	2.65	2.05	1.87	1.80	2.48	2.54	2.68
17	2.30	2.70	2.60	2.05	1.85	1.80	2.48	2.53	2.68
18	2.40	2.65	2.50	2.05	1.80	1.80	2.48	2.53	2.69
19	2.40	2.60	2.40	2.20	1.80	1.80	2.47	2.53	2.68
20	2.40	2.58	2.50	2.40	1.85	1.80	2.46	2.53	2.69
21	2.40	2.50	2.45	2.30	1.85	1.80	2.46	2.53	2.70
22	2.40	2.50	2.43	2.30	1.85	1.80	2.45	2.53	2.70
23	2.39	2.48	3.00	2.20	1.85	1.80	2.45	2.53	2.71
24	2.38	2.45	2.80	2.20	1.85	1.80	2.45	2.53	2.70
25	2.38	2.40	3.00	2.20	1.85	1.80	2.45	2.53	2.71
26	2.38	2.40	2.70	2.30	1.85	1.80	2.46	2.53	2.72
27	2.38	2.40	2.75	2.40	1.82	1.80	2.48	2.53	2.72
28	2.38	2.80	2.60	2.35	1.80	1.80	2.48	2.53	2.70
29	2.38	2.60	2.90	2.20	1.80	1.80	2.49	2.53	2.70
30	2.38	.....	2.70	2.20	1.80	1.80	2.50	2.53	2.70
31	2.38	.....	2.60	.....	1.80	(a)	2.50	.....	3.00

[a] No gage record during July, August, and September.

Rating table for Santa Maria River near Santa Maria, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.75	0.0	2.20	3	2.90	40	3.60	220
1.80	.2	2.30	5	3.00	53	3.70	265
1.85	.3	2.40	7	3.10	70	3.80	325
1.90	.5	2.50	10	3.20	90	3.90	400
1.95	.7	2.60	13	3.30	115	4.00	500
2.00	1	2.70	18	3.40	140		
2.10	2	2.80	27	3.50	175		

Estimated monthly discharge of Santa Maria River near Santa Maria, Cal., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January	7	5	5.9	363
February	70	7	12.2	702
March	220	6	28.2	1,734
April	14	1.5	4.0	238
May	3	.2	1.1	68
June	.2	.2	.2	12
October	450	8	109.0	6,702
November	12	10	10.7	637
December	53	11	17.3	1,064
The period				11,520

MOHAVE RIVER AT VICTORVILLE, CAL.

At Victorville, a station on the Atchison, Topeka and Santa Fe Railway, the river passes through a narrow gorge, locally known as The Narrows. This place has been under investigation as a possible dam site, and soundings for the depth of bed rock were made by the United States Geological Survey during the season of 1899. The greatest depth of bed rock was found to be 54 feet. The diamond drill showed the rock to be a fine granite. A more detailed account of this exploration will be found in the Twenty-first Annual Report, part 4. Above The Narrows the valley broadens into a large reservoir site, but as no surveys of it have been made the capacity is unknown. In order to determine the amount of water available for storage for this reservoir a gaging station was established February 27, 1899. The channel is in sand, which is constantly shifting. The rod readings are of little value during low stages. Between January 1, 1902, and May 3, 1902, the discharge varied from 47 to 67 cubic feet per second, though the gage reading was 0.9 for the entire time. At the latter date the rod readings were discontinued. The mean estimated discharge for each month has been obtained by averaging the discharge as obtained by meter measurements made during the month.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Mohave River at Victorville, Cal., in 1904.[a]

Date.	Hydrographer.	Discharge.	Date.	Hydrographer.	Discharge.
		Sec.-ft.			*Sec.-ft.*
January 7	P. H. Leahy	62	August 23	P. H. Leahy	42
January 16	do	67	August 26	do	35
January 23	do	58	August 30	do	33
January 28	do	45	September 3	do	36
January 30	do	62	September 6	do	36
February 7	do	57	September 9	do	34
February 15	do	62	September 15	do	31
February 20	do	52	September 17	do	33
February 29	do	54	September 20	do	32
March 5	do	68	September 26	do	39
March 14	do	51	September 30	do	34
March 28	do	60	October 4	do	41
April 6	do	49	October 7	do	47
April 16	do	41	October 11	do	49
April 25	do	42	October 15	do	49
April 30	do	40	October 18	do	48
May 8	do	46	October 22	do	53
May 16	do	48	October 25	do	51
May 23	do	51	October 28	do	52
May 31	do	44	November 1	do	54
June 6	do	43	November 4	do	48
June 14	do	40	November 8	do	47
June 21	do	30	November 11	do	49
June 27	do	37	November 15	do	47
June 28	W. B. Clapp	28	November 18	do	47
July 2	P. H. Leahy	36	November 22	do	51
July 12	do	29	November 25	do	52
July 15	do	30	November 29	do	53
July 18	do	32	December 2	do	53
July 22	do	32	December 6	do	53
July 26	do	40	December 9	do	66
July 29	do	34	December 13	do	70
August 2	do	34	December 16	do	56
August 5	do	31	December 20	do	59
August 9	do	32	December 23	do	59
August 12	do	33	December 27	do	59
August 16	do	31	December 30	do	58
August 19	do	46			

[a] Small flood discharge on March 23, of which measurement was not obtained on account of poor conditions. Estimated discharge 500 second-feet for short period. Stream soon assumed natural conditions.

Estimated monthly discharge of Mohave River at Victorville, Cal., for 1904.[a]

[Drainage area, 400 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	67	45	60	3,689	0.15	0.17
February	62	52	57	3,279	.14	.15
March	68	51	58	3,566	.14	.16
April	55	40	45	2,678	.11	.12
May	51	41	47	2,890	.12	.14
June	44	28	38	2,261	.10	.11
July	40	29	33	2,029	.08	.09
August	46	31	35	2,152	.09	.10
September	39	31	34	2,023	.08	.09
October	54	36	48	2,951	.12	.14
November	54	47	50	2,975	.12	.13
December	70	53	59	3,628	.15	.17
The year	70	28	47	34,121	.12	1.57

[a] Daily discharge obtained by interpolation between discharge measurements.

MISCELLANEOUS DISCHARGE MEASUREMENTS IN SOUTHERN CALIFORNIA.

The following miscellaneous measurements were made in southern California drainage:

Miscellaneous discharge measurements in southern California.

SANTA MARIA RIVER DRAINAGE.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Second-ft.*
Aug. 25	W. B. Clapp	Sisquoc River	Sisquoc ranch	1.1
Oct. 23	do	do	do	0.0

VENTURA RIVER DRAINAGE.

1903.				
Sept. 19	W. B. Clapp	Ventura River	Ventura Light and Power Co. Upper diversion city supply.	7.0
Sept. 19	do	do	Below upper diversion	3.7
		Total river		10.7
Sept. 19	do	Power ditch	At old mill	3.3

Miscellaneous discharge measurements in southern California—Continued.

SANTA CLARA RIVER DRAINAGE.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Second-ft.*
June 16	W. B. Clapp	Newhall ditch	Southern Pacific Rwy. bridge, 3 miles below Saugus.	1.7
Sept. 16	do	do	do	1.8
Apr. 30	do	Santa Clara River	Road crossing Newhall ranch.	8.0
June 16	do	do	do	6.2
Sept. 16	do	do	do	5.4
Apr. 30	do	San Francisquito Creek	do	2.0
June 16	do	do	do	2.4
Sept. 16	do	do	do	2.0
Apr. 30	do	Santa Clara River	Opposite head of Camulas ditch.	25.0
June 17	do	do	do	21.1
		Camulas ditch	At head	7.6
		Total Santa Clara River.		28.7
Sept. 16	do	Santa Clara River	Camulas ditch	5.1
		Camulas ditch	At head	11.6
		Total Santa Clara River.		16.7
May 3	do	Santa Clara River	1 mile above Santa Paula.	127.0
June 22	do	do	do	22.0
		Richardson ditch	do	4.2
		Grees ditch	do	11.0
		Farmer's ditch	do	7.8
		Total Santa Clara River.		45.0
July 16	do	Santa Clara River	1 mile above Santa Paula.	23.4
		Richardson ditch	do	2.3
		Grees ditch	do	5.8
		Farmer's ditch	do	8.4
		Total Santa Clara River.		39.9
Aug. 13	J. B. Lippincott and G. S. Power.	Santa Clara River	1 mile above Santa Paula.	20.8
		Richardson ditch	do	1.2
		Grees ditch	do	11.1
		Farmer's ditch	do	8.6
		Total Santa Clara River.		41.7

Miscellaneous discharge measurements in southern California—Continued.

SANTA CLARA RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge
1903.				*Second-ft.*
Sept. 18	W. B. Clapp	Santa Clara River	1 mile above Santa Paula.	18.2
		Richardson ditch	do	1.2
		Grees ditch	do	7.4
		Farmer's ditch	do	8.6
		Total Santa Clara River.		35.4
July 15	W. B. Clapp and G. S. Power.	Santa Clara Water and Irrigation Co.'s canal.	At head	30
July 16	do	do	do	33
Aug. 14	J. B. Lippincott and G. S. Power.	do	do	31.6
		Santa Clara River	Below head of canal	3.3
		Total river		34.9
Sept. 18	W. B. Clapp	Santa Clara Water and Irrigation Co.'s canal.	Heading	26.7
		River	Below canal heading	3.9
		Total river		30.6
May 1	do	Piru Creek	Dunton ranch	57
		do	Southern Pacific Rwy. bridge.	55
June 17	do	do	Upper diversion Piru Land and Water Co.	1.8
		do	1 mile above Esperanza	3.9
		Total Piru Creek		5.7
Sept. 17	do	Upper diversion	1 mile above Esperanza	1.2
		Lower diversion	Southern Pacific Rwy. bridge.	1.0
		Piru Creek	do	.1
		Total Piru Creek		1.1
June 17	do	Lower diversion	Southern Pacific Rwy. bridge.	3.7
		Piru Creek	do	2.7
		Total Piru Creek		6.4

Miscellaneous discharge measurements in southern California—Continued.

SANTA CLARA RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Second-ft.*
May 2	W. B. Clapp	Sespe Creek	Southern Pacific Rwy. bridge.	89
Sept. 17	do	Sespe Land and Water Co's. canal.	½ mile below head	4.6
		Sespe Creek	Below canal heading	.1
		Total Sespe Creek.		4.7
May 3	do	Santa Paula Creek	5 miles above Santa Paula.	28
		do	At Santa Paula	19.0
		Santa Paula Water Co's. ditch.	At Heading	5.6
June 22	do	do	do	10.1
Sept. 18	do	do	do	2.7

SANTA YNEZ RIVER DRAINAGE.

1903.				
Apr. 11	Howard Rankin	Amagusa Creek	At mouth	6.2
Apr. 15	do	do	do	4.5
Apr. 21	do	do	do	7.6
Apr. 23	do	do	do	6.9
Apr. 28	do	do	do	6.3
Apr. 10	do	Blue Canyon Creek	do	11.1
Apr. 22	do	do	do	11.7
Apr. 29	do	do	do	6.3
Apr. 10	do	Trail Creek	do	1.4
Apr. 22	do	do	do	2.0
Apr. 11	do	Ruiz Creek	do	5.4
Apr. 15	do	do	do	4.3
Apr. 21	do	do	do	7.0
Apr. 23	do	do	do	5.7
Apr. 28	do	do	do	4.5

Miscellaneous discharge measurements in southern California—Continued.

SAN LUIS REY RIVER DRAINAGE.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Second-ft.*
Aug. 15	W. B. Clapp	San Louis Rey River	Dam site, Warner's ranch reservoir.	2.8
Aug. 14	do	do	Above head of Escondido canal.	.5
Aug. 16	do	do	Pala, Cal	1.1
Aug. 15	do	Sickler's canal	Sickler's ranch	2.1
Oct. 9	do	do	do	2.1

LOS ANGELES RIVER DRAINAGE.

1903.				
Apr. 9	J. C. Clausen	Pacoima Creek	Mouth of canyon	47
Apr. 18	do	do	do	98
May 5	do	do	do	24
June 5	W. B. Clapp	do	do	8.0
Sept. 26	do	do	do	0.0
Apr. 9	J. C. Clausen	do	Southern Pacific Rwy.	32
Apr. 19	do	do	do	57
May 5	do	do	do	16.0
June 5	W. B. Clapp	do	do	0.0
Apr. 18	J. C. Clausen	do	3¼ miles below Southern Pacific Rwy.	0.0
May 5	do	do	1½ miles below Southern Pacific Rwy.	0.0
Apr. 10	do	Little Tejunga Creek	Mouth of canyon	10.0
Apr. 17	do	do	do	27
May 5	do	do	do	4.0
June 4	W. B. Clapp	do	do	1.0
Sept. 26	do	do	do	0.0
Apr. 10	J. C. Clausen	Big Tejunga Creek	do	59
Apr. 17	do	do	do	157
May 5	do	do	do	37
June 4	W. B. Clapp	do	do	12.0
Sept. 26	do	do	do	.1
Apr. 9	J. C. Clausen	do	Southern Pacific Rwy.	2.0
Apr. 17	do	do	do	124
May 5	do	do	do	0.0
June 4	W. B. Clapp	do	do	0.0
Apr. 17	J. C. Clausen	do	1½ miles below Southern Pacific Rwy.	0.0
Mar. 25	J. F. Danforth	Los Angeles River	Los Feliz Bridge	109

Miscellaneous discharge measurements in southern California—Continued.

LOS ANGELES RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Second-ft.*
Apr. 8	J. C. Clausen	Los Angeles River	Los Feliz Bridge	37
Apr. 13	O. W. Peterson	do	do	28
Apr. 17	do	do	do	64
Jan. 28	C. A. Miller	do	Aliso Street Bridge	66
Apr. 11	J. C. Clausen	do	Ninth Street Bridge	20
Apr. 18	O. W. Peterson	do	do	106
Apr. 18	do	do	Boyle avenue	75
Apr. 18	do	do	Opposite Bell station	73
Apr. 20	do	do	Above junction of Rio Hondo.	25
Apr. 20	do	do	Below junction of Rio Hondo.	54
Apr. 20	O. W. Peterson	do	One-half mile above Compton and Clearwater road.	82
Apr. 20	do	do	Opposite Clearwater	53
Apr. 21	do	do	One-half mile above Cerritos road.	39
Apr. 21	do	do	1½ miles below Cerritos road.	77
Apr. 21	do	do	Opposite Seabright	78
Apr. 13	W. B. Clapp	Arroyo Seco	At mouth of canyon	24
Apr. 17	do	do	do	100
May 21	do	do	do	10.0
Apr. 13	do	do	At Devils Gate	17.0
May 21	do	do	do	2.0
May 21	do	do	1 mile below Devils Gate.	0.0
Apr. 13	do	do	At Sheep Corral Spring, Pasadena.	4.0
Apr. 17	do	do	do	80
Apr. 13	do	do	Garvanza wagon bridge.	0.0
Jan. 28	C. A. Miller	do	At Avenue 26, Los Angeles.	274
Mar. 25	J. F. Danforth	do	do	128
Apr. 17	O. W. Peterson	do	do	77

Los Angeles River at Los Angeles, Cal.

LOS ANGELES RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Discharge.	Remarks.
1904.		*Sec.-feet.*	
April 15	F. B. Cook	42.3	44-inch conduit.
		4.5	Main-supply ditch.
		46.8	Total diversion Los Angeles River.
May 25	W. B. Clapp	40.0	44-inch conduit.
	F. B. Cook	8.0	Main-supply conduit.
		48.0	Total diversion Los Angeles River.
June 18	F. B. Cook	29.2	44-inch conduit.
		10.8	Main-supply conduit.
		40.0	Total diversion Los Angeles River.
June 27	W. B. Clapp	34.2	44-inch conduit.
	E. C. LaRue	8.6	Main-supply conduit.
		3.7	River at Huron street.
		46.5	Total Los Angeles River.
June 24	F. B. Cook	31.7	44-inch conduit.
		8.6	Main-supply conduit.
		40.3	Total diversion Los Angeles River.
July 19	E. C. LaRue	33.1	44-inch conduit.
	F. B. Cook	10.2	Main-supply conduit.
		5.3	River at Huron street.
		48.6	Total Los Angeles River.
August 9	F. B. Cook	29.9	44-inch conduit.
		10.4	Main-supply conduit.
		40.3	Total diversion Los Angeles River.
August 18	E. C. LaRue	30.5	44-inch conduit.
	F. B. Cook	10.8	Main-supply conduit.
		3.6	River at Huron street.
		44.9	Total Los Angeles River.
September 7	F. B. Cook	29.7	44-inch conduit.
		10.4	Main-supply conduit.
		40.1	Total diversion Los Angeles River.

Los Angeles River at Los Angeles, Cal.—Continued.

LOS ANGELES RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Discharge.	Remarks.
1904.		*Sec.-feet.*	
September 20	E. C. LaRue	31.1	44-inch conduit.
		11.0	Main-supply conduit.
		3.4	River at Huron street.
		45.5	Total Los Angeles River.
October 20	do	31.9	44-inch conduit.
		11.6	Main-supply conduit.
		8.2	River at Huron street.
		51.7	Total Los Angeles River.
October 25	F. B. Cook	31.4	44-inch conduit.
		11.6	Main-supply conduit.
		43.0	Total diversion Los Angeles River.
November 18	E. C. LaRue F. B. Cook	33.3	44-inch conduit.
		11.8	Main-supply conduit.
		8.4	River at Huron street.
		53.5	Total Los Angeles River.
December 28	E. C. LaRue	27.7	44-inch conduit.
		10.0	Main-supply conduit.
		22.2	River at Huron street.
		59.9	Total Los Angeles River.

Miscellaneous discharge measurements in southern California.

SAN GABRIEL RIVER DRAINAGE.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Sec.-feet.*
Apr. 20	W. B. Clapp and J. C. Clausen.	Dalton Creek	At mouth of canyon	9.0
May 22	W. B. Clapp	do	do	2.7
Sept. 14	do	do	do	0.0
May 22	do	do	1 mile below mouth of canyon.	0.0
Apr. 20	do	do	Southern California Rwy.	0.0

Miscellaneous discharge measurements in southern California—Continued.

SAN GABRIEL RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Second-ft.*
Apr. 20	W. B. Clapp and J. C. Clausen.	San Dimas Creek	Mouth of canyon	19.0
May 22	W. B. Clapp	do	do	2.5
Sept. 14	do	do	do	0.0
Apr. 20	do	do	Base Line avenue	0.0
Apr. 18	do	Santa Anita Creek	Mouth of canyon	35.0
1903.				
May 23	W. B. Clapp	Santa Anita Creek	Mouth of canyon	10
		Baldwin diversion heading.		3
		Total creek		13
Sept. 9	do	Baldwin diversion heading.		1.4
1902.				
July 29	J. A. Worthen	Baldwin ditch	Point (1)	3.2
Aug. 18	do	do	do	3.7
Sept. 8	do	do	do	.91
Sept. 27	do	do	do	2.0
Oct. 15	do	do	do	1.6
1904.				
June 15	J. A. Worthen	Baldwin ditch	Point (1)	3.0
July 8	do	do	do	3.4
Aug. 31	do	do	do	3.0
Sept. 24	do	do	do	2.8
Oct. 5	W. B. Clapp	do	do	2.9
Oct. 15	J. A. Worthen	do	do	[a] .2
1902.				
July 20	J. A. Worthen	Baldwin ditch	Point (3)	1.2
Aug. 18	do	do	do	.70
Sept. 8	do	do	do	.72
Sept. 27	do	do	do	.63
Oct. 11	do	do	do	.75
1904.				
June 15	J. A. Worthen	Baldwin ditch	Point (3)	1.4
June 8	do	do	do	.96
Aug. 31	do	do	do	.80

[a] Estimated. Main stream flowing through waste gate into old channel.

Miscellaneous discharge measurements in southern California—Continued.

SAN GABRIEL RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Second-ft.*
Sept. 24	J. A. Worthen	Baldwin ditch	Point (3)	0.94
Oct. 15	do	do	do	.78
1902.				
July 29	J. A. Worthen	Baldwin ditch	Point (4)	1.9
Aug. 18	do	do	do	1.2
Sept. 8	do	do	do	.99
Sept. 27	do	do	do	.52
Oct. 11	do	do	do	.81
1904.				
June 15	J. A. Worthen	Baldwin ditch	Point (4)	[a] .00
July 8	do	do	do	.00
Aug. 31	do	do	do	.62
Oct. 15	do	do	do	[b] .00
1903.				
Apr. 18	W. B. Clapp	Santa Anita Creek	Southern Pacific Railway, Monrovia Branch.	0
May 23	do	do	White Oak avenue	0
Apr. 18	do	Little Santa Anita Creek.	Above Santa Anita Creek.	5
Apr. 18	do	Eaton Canyon Creek	Mouth of canyon	29
May 21	do	do	do	3
		do	Water company's diversion at heading, mouth of canyon.	3
		Total creek		6
Sept. 9	do	Eaton Canyon Creek	Mouth of canyon	0
Apr. 18	do	do	At Southern California Railway.	0
May 21	do	do	1 mile above Southern California Railway.	0
Apr. 14	do	San Gabriel River	At upper road crossing, Duarte to Azusa.	264
May 26	do	do	Below head of Lexington wash.	29
		do	Diversion below head of Lexington wash.	37
		Total river at same place.		66

[a] No diversion. Ditch not kept up. [b] No water used.

Miscellaneous discharge measurements in southern California—Continued.

SAN GABRIEL RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Second-ft.*
Apr. 15	W. B. Clapp	San Gabriel River	At El Monte Bridge	50
Apr. 15	do	do	Lexington wash at El Monte.	3
Apr. 26	O. W. Peterson	do	At El Monte Bridge	229
May 26	W. B. Clapp	do	do	0
Apr. 25	O. W. Peterson	do	At road crossing east of Durfee's ranch.	264
Apr. 25	do	do	Whittier road crossing	361
Apr. 24	do	do	Southern California Railway at Rivera.	365
Apr. 24	do	do	Southern Pacific Railway at Studebaker.	364
Apr. 23	do	do	Opposite Alamitos	311.
1902.				
Aug. 18	J. A. Worthen	Rio Hondo	Old Mission Bridge	24.3
Sept. 8	do	do	do	25.6
Sept. 27	do	do	do	21.5
Oct. 11	do	do	do	24.7
1903.				
Apr. 27	O. W. Peterson	Rio Hondo	Old Mission Bridge	36
Oct. 2	W. B. Clapp	do	do	29
1904.				
June 15	J. A. Worthen	Rio Hondo	Old Mission Bridge	22
July 8	do	do	do	24.1
Aug. 31	do	do	do	22.2
Sept. 24	do	do	do	21.7
Oct. 5	W. B. Clapp	do	do	22
Oct. 15	J. A. Worthen	do	do	27
1903.				
Apr. 27	O. W. Peterson	Rio Hondo	Whittier road crossing	17
Apr. 27	do	do	Road crossing west of Rivera.	12
Apr. 27	do	do	Southern Pacific Railway west of Downey.	12
Apr. 20	do	do	At S. P., L. A. & S. L. Railroad, above Workman.	29
Apr. 25	do	San Jose Creek	Whittier and Puente road.	8
Oct. 3	W. B. Clapp	Sheep Creek ditch	Whittier flume crossing.	4.6

Miscellaneous discharge measurements in southern California—Continued.

SAN GABRIEL RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1904.				*Second-ft.*
Oct. 5	W. B. Clapp	Sheep Creek ditch	Whittier flume crossing.	1.4
1903.				
Oct. 3	W. B. Clapp	Rincon ditch	Rincon road crossing	3.4
1904.				
Oct. 5	W. B. Clapp	Rincon ditch	Rincon road crossing	1.5
1903.				
Oct. 3	W. B. Clapp	Durfee ditch	Road crossing above ranch house.	1.6
1904.				
Oct 5	W. B. Clapp	Durfee ditch	Road crossing above ranch house.	0
1903.				
Oct. 2	W. B. Clapp	Los Nietos or Banta ditch.	At heading	28.0
1904.				
Oct. 5	W. B. Clapp	Los Nietos or Banta ditch.	100 feet below division box.	19.5
1903.				
Oct. 2	W. B. Clapp	Ranchito or Standeferd ditch.	At heading	14
1904.				
Oct. 5	W. B. Clapp	Ranchito or Standeferd ditch.	At heading	12.9
1903.				
Oct. 2	W. B. Clapp	Cate ditch	In flume at road crossing.	5.5
1904.				
Oct. 11	W. B. Clapp	Cate ditch	In flume at road crossing.	11.1
1902.				
July 25	J. A. Worthen	Arroyo ditch	At dam	21.7
1904.				
June 15	J. A. Worthen	Arroyo ditch	At dam	20.6
July 8	do	do	do	19.7
Aug. 31	do	do	do	18.6
Sept. 24	do	do	do	17.9
Oct. 15	do	do	do	20.8
1902.				
Sept. 27	J. A. Worthen	Arroyo ditch	At intake	24.6
Oct. 11	do	do	do	24.2

Miscellaneous discharge measurements in southern California—Continued.

SAN GABRIEL RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1904.				*Second-ft.*
June 21	W. B. Clapp and O. K. Parker.	Arroyo ditch	At intake	21.7
1902.				
Sept. 8	J. A. Worthen	Arroyo ditch	At Salt Lake Railway	19.6
Oct. 11	do	do	do	20.5
1904.				
June 15	J. A. Worthen	Arroyo ditch	At Salt Lake Railway	17.5
July 8	do	do	do	17.9
Aug. 18	do	do	do	20.6
Aug. 31	do	do	do	16.4
Sept. 24	do	do	do	17.0
Sept. 27	do	do	do	18.8
Oct. 15	do	do	do	18.5
June 21	W. B. Clapp and O. K. Parker.	do	do	19.4
1902.				
Aug. 18	J. A. Worthen	Arroyo ditch	At point of diversion	23.7
Sept. 8	do	do	do	23.2
1904.				
June 21	W. B. Clapp and O. K. Parker.	Arroyo ditch	At head of flume	16.7
Aug. 31	J. A. Worthen	do	do	16.2
Sept. 24	do	do	do	15.5
Oct. 10	do	do	do	18.6
1903.				
Apr. 25	J. B. Lippincott	Arroyo ditch	Southern California Railway, Rivera.	21
Oct. 3	W. B. Clapp	Whittier ditch	Pumping plant east of El Monte—developed water—discharge varies as needed.	5.1

SANTA ANA RIVER DRAINAGE.

1903.				
Apr. 1	W. B. Clapp	San Antonio Creek	Ontario Power Co.'s power house, mouth of canyon.	854
1904.				
Sept. 23	W. B. Clapp	San Antonio Creek	At power house, waste weir. Total creek.	6.4

Miscellaneous discharge measurements in southern California—Continued.

SANTA ANA RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Second-ft.*
Apr. 21	W. B. Clapp and J. C. Clausen.	San Antonio Creek	At power house, mouth of canyon.	42
		do	San Antonio Water Co.'s diversion, mouth of canyon.	15
		Total creek		57
1903.				
May 25	W. B. Clapp	San Antonio Creek	At power house, mouth of canyon.	14
		do	San Antonio Water Co.'s diversion mouth of canyon.	20
		Total creek		34
July 3	do	San Antonio Creek	At power house, mouth of canyon. Total creek.	19.5
Sept. 13	do	do	do	11
Apr. 21	W. B. Clapp and J. C. Clausen.	do	1 mile below Southern Pacific Rwy.	.0
May 25	W. B. Clapp	do	Southern Pacific Rwy.	.0
Apr. 21	W. B. Clapp and J. C. Clausen.	Cucamonga Creek	Mouth of canyon	15
May 25	W. B. Clapp	do	do	5.5
1904.				
Sept. 23	W. B. Clapp	Cucamonga Creek	At point of diversion of Cucamonga Water Co.	1.8
1903.				
Sept. 13	W. B. Clapp	Cucamonga Creek	Above head works Hermosa Water Co.	3.6
Apr. 21	W. B. Clapp and J. C. Clausen.	do	Southern California Rwy.	.0
May 25	W. B. Clapp	do	Base line avenue	.0
Apr. 1	do	Lytle Creek	At mouth of canyon	1,790
Apr. 22	W. B. Clapp and J. C. Clausen.	do	do	56
		Rialto canal	Weir at head works	7
		Total creek		63

Miscellaneous discharge measurements in southern California—Continued.

SANTA ANA RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Second-ft.*
May 19	W. B. Clapp...	Lytle Creek.....	Mouth of canyon	14.6
		Rialto canal.....	Weir at head works...	14.9
		Total creek	.....	29.5
July 2	.....do	Lytle Creek.....	Weir at head works Rialto canal. Total creek.	16.5
Sept. 12	.....do	.....do	.....do.....	14.7
1904.				
Sept. 22	W. B. Clapp...	Lytle Creek.....	At mouth of canyon. Total creek.	9.2
1903.				
Apr. 22	W. B. Clapp...	Lytle Creek	Highland avenue.....	.0
May 19	.....do	.....do	.....do.....	.0
Apr. 23	W. B. Clapp and J. C. Clausen.	West Twin Creek	Mouth of canyon	8.6
May 18	W. B. Clapp...	.....do	.....do.....	2.1
		.....do	Ditch diversion.....	2.3
		Total creek	.....	4.4
Sept. 11	.....do	West Twin Creek	Mouth of canyon. Total creek.	0.3
1904.				
Sept. 21	W. B. Clapp...	West Twin Creek ditch	Head of pipe line.....	0.4
1903.				
Apr. 23	W. B. Clapp...	West Twin Creek	Southern California Rwy.	.0
May 18	.....do	.....do	1 mile above Southern California Rwy.	.0
Apr. 23	W. B. Clapp and J. C. Clausen.	East Twin Creek	Mouth of canyon	10.0
May 17	W. B. Clapp...	.....do	.....do.....	3.2
		.....do	Ditch diversion.....	1.6
		Total creek	.....	4.8
Sept. 11	.....do	East Twin Creek	Ditch diversion. Total creek.	.4
1904.				
Sept. 22	W. B. Clapp...	East Twin Creek	Wier at head of pipe line.	0.6

Miscellaneous discharge measurements in southern California—Continued.

SANTA ANA RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Second-ft.*
Apr. 23	W. B. Clapp	East Twin Creek	1 mile above Southern California Rwy.	.0
May 17	do	do	do	.0
Apr. 23	W. B. Clapp and J. C. Clausen.	City Creek	Mouth of canyon	22
May 17	W. B. Clapp	do	do	4.4
		do	Canal diversion	6.8
		Total creek		11.2
Sept. 11	do	City Creek	Mouth of canyon. Total creek.	.2
1904.				
Sept. 22	W. B. Clapp	City Creek	Mouth of canyon. Total creek.	0.5
1903.				
Apr. 23	W. B. Clapp	City Creek	Road crossing south Harlem Springs.	.0
May 17	do	do	Base line avenue	.0
Apr. 23	W. B. Clapp and J. C. Clausen.	Plunge Creek	Mouth of canyon	23
May 17	W. B. Clapp	do	do	3
		do	Diversion mouth of canyon.	6
		Total creek		9
Sept. 11	do	Plunge Creek	Mouth of canyon. Total creek.	.6
1904.				
Sept. 21	W. B. Clapp	Plunge Creek	Above Highland canal.	0.6
1903.				
Apr. 23	W. B. Clapp	Plunge Creek	Orange avenue	.0
May 17	do	do	do	.0
1904.				
Mar. 22	W. B. Clapp and E. C. Murphy.	Mill Creek	Wier at Edison electric power house, Nos. 2 and 3.	17.6
Sept. 21	W. B. Clapp	do	do	14.1
Nov. 11	E. C. La Rue	do	do	11.2
1903.				
Apr. 1	W. B. Clapp	Mill Creek	Head of Crafton zanja.	1,280

Miscellaneous discharge measurements in southern California—Continued.

SANTA ANA RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1904.				*Second-ft.*
Sept. 21	W. B. Clapp	Crafton zanja		15.2
Nov. 11	E. C. La Rue	do		14.1
1903.				
Apr. 24	W. B. Clapp and J. C. Clausen.	Mill Creek	Head of Crafton zanja.	34
		Crafton zanja	do	5
		Total Mill Creek.	do	39
May 16	W. B. Clapp	Mill Creek	do	19
		Crafton zanja	do	49
		Total Mill Creek.	do	68
June 9	do	Mill Creek	do	2
		Crafton zanja	do	44
		Total Mill Creek.	do	46
July 1	do	Crafton zanja	At head; total Mill Creek.	29
Sept. 1	do	do	do	22
Aug. 31	do	Morton Canyon	Mouth of canyon	.2
1904.				
May 28	W. B. Clapp	Morton Canyon	Mouth of canyon	.13
Sept. 21	do	do	do	.14
1903.				
Aug. 31	W. B. Clapp	Redlands tunnel	At outlet	1.8
1904.				
May 28	W. B. Clapp	Redlands tunnel	At outlet	1.59
June 29	do	do	do	1.55
Sept. 21	do	do	do	1.04
1903.				
Aug. 31	W. B. Clapp	Green Spot pipe line	Weir at head	6.3
1904.				
Jan. 29	W. B. Clapp	Green Spot pipe line	Weir at head	4.2
May 14	do	do	do	1.8
May 28	do	do	do	4.9
June 29	do	do	do	7.3
Sept. 21	do	do	do	6.0
Nov. 11	E. C. La Rue	do	do	1.1

Miscellaneous discharge measurements in southern California—Continued.

SANTA ANA RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Second-ft.*
Apr. 24	W. B. Clapp	Highland canal	Weir at head	6
May 16	do	do	do	18
Aug. 31	do	do	do	15.6
1904.				
Jan. 29	W. B. Clapp	Highland canal	Weir at head	10.7
May 14	do	do	do	11.4
May 28	do	do	do	12.0
June 29	do	do	do	13.5
Sept. 21	do	do	do	16.4
Nov. 11	E. C. La Rue	do	do	7.8
1903.				
Apr. 24	W. B. Clapp	Redlands canal	Sand-box weir	9.6
May 16	do	do	do	29.0
Aug. 31	do	do	do	28.0
1904.				
Jan. 29	W. B. Clapp	Redlands canal	Sand-box weir	12.3
May 14	do	do	do	23.8
May 28	do	do	do	26.0
June 29	do	do	do	22.0
Nov. 11	E. C. La Rue	do	do	9.6
1903.				
Sept. 5	K. Sanborn	Castile ditch	1,000 feet below heading.	3
1904.				
May 15	K. Sanborn	Castile ditch	1,000 feet below heading.	.0
Aug. 18	do	do	do	.0
1903.				
Sept. 5	K. Sanborn	Wilbur ditch	At Rogers' pipe trestle crossing.	1.7
1904.				
May 15	K. Sanborn	Wilbur ditch	At Rogers' pipe trestle crossing.	2.54
Aug. 20	do	do	do	2.13
1903.				
Sept. 5	K. Sanborn	Newton ditch	West line section 28	4.1
1904.				
May 15	K. Sanborn	Newton ditch	West line section 28	4.7
Aug. 20	do	do	do	7.7

Miscellaneous discharge measurements in southern California—Continued.

SANTA ANA RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Second-ft.*
Sept. 5	K. Sanborn	Fuller ditch	At heading	13.4
1904.				
May 15	K. Sanborn	Fuller ditch	1 mile below intake	11.2
Aug. 20	do	do	do	4.6
1903.				
Sept. 5	K. Sanborn	Roberts ditch	At heading	2.6
1904.				
May 15	K. Sanborn	Roberts ditch	At heading	2.2
Aug. 20	do	do	do	1.4
1903.				
Sept. 23	W. B. Clapp	Newberry ditch	Auburndale Bridge	3.3
1904.				
May 15	K. Sanborn	Newberry ditch	Auburndale Bridge	.94
Aug. 20	do	do	do	2.7
1903.				
Sept. 23	W. B. Clapp	Durkee ditch	Auburndale Bridge	3.4
1904.				
May 15	K. Sanborn	Durkee ditch	Auburndale Bridge	.0
Aug. 20	do	do	do	.0
1903.				
Sept. 23	W. B. Clapp	Gilliland ditch	Auburndale Bridge	1.2
1904.				
May 15	K. Sanborn	Gilliland ditch	Auburndale Bridge	.61
Aug. 20	do	do	do	.42
1903.				
Apr. 30	O. W. Peterson	Santa Ana canal	1 mile below heading	43
Sept. 23	W. B. Clapp	do	do	34
Apr. 29	O. W. Peterson	Anaheim and Fullerton canal.	Heading	2.8
Sept. 25	W. B. Clapp	do	At Esperanza	32
Sept. 25	do	Yorba ditch	do	.6
May 15	W. B. Clapp and J. M. Mylne.	Santa Ana River	At Orange avenue	30
May 15	do	do	½ mile below Orange avenue.	.0
Apr. 22	W. B. Clapp and J. C. Clausen.	do	Colton Bridge	13

Miscellaneous discharge measurements in southern California—Continued.

SANTA ANA RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Second ft.*
May 18	W. B. Clapp	Santa Ana River	Colton Bridge	.0
Sept. 23	do	do	Auburndale Bridge	58
Mar. 31	do	do	Rincon wagon bridge	400
Apr. 29	O. W. Peterson	do	do	193
May 18	W. B. Clapp	do	do	108
June 12	do	do	do	85
July 23	do	do	do	59
Aug. 19	do	do	do	60
Sept. 23	do	do	do	78
Oct. 30	do	do	do	93
Nov. 25	do	do	do	102
1904.				
Jan. 26	W. B. Clapp	Santa Ana River	Rincon wagon bridge	109
Feb. 29	do	do	do	162
Mar. 21	W. B. Clapp and E. C. Murphy.	do	do	107
Apr. 29	W. B. Clapp	do	do	96
May 23	do	do	do	82
June 20	W. B. Clapp and W. V. Hardy.	do	do	63
July 23	E. C. La Rue	do	do	62
Aug. 20	do	do	do	69
Sept. 20	W. B. Clapp	do	do	74
Sept. 28	E. C. La Rue	do	do	75
Oct. 22	do	do	do	73
Nov. 19	do	do	do	103
Dec. 10	do	do	do	110
1903.				
Apr. 29	O. W. Peterson	Santa Ana River	1 mile above heading of Santa Ana and Anaheim canals.	214
Sept. 23	W. B. Clapp	do	Heading Santa Ana and Anaheim canals.	72
1904.				
Sept. 28	E. C. La Rue	Santa Ana River	Heading Santa Ana and Anaheim canals.	66
1903.				
Apr. 29	O. W. Peterson	Santa Ana River	2 miles below heading Santa Ana and Anaheim canals.	185
Apr. 30	do	do	2 miles above Yorba	130
Apr. 30	do	do	½ mile above Yorba	141

Miscellaneous discharge measurements in southern California—Continued.

SANTA ANA RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Second-ft.*
May 1	O. W. Peterson	Santa Ana River	¾ mile above Southern California Rwy. crossing at Olive.	51
May 1	do	do	¾ mile below Southern California Rwy. crossing at Olive.	.0
Mar. 31	W. B. Clapp	Chino Creek	At Rincon wagon bridge.	146
Apr. 29	O. W. Peterson	do	do	23
May 18	W. B. Clapp	do	do	15
June 12	do	do	do	6.5
July 23	do	do	do	3.4
Aug. 19	do	do	do	2.4
Sept. 23	do	do	do	3.3
Oct. 30	do	do	do	6
Nov. 25	do	do	do	9.2
1904.				
Jan. 26	W. B. Clapp	Chino Creek	At Rincon wagon bridge.	14.7
Feb. 29	do	do	do	24
Mar. 21	W. B. Clapp and E. C. Murphy.	do	do	16.0
Apr. 29	W. B. Clapp	do	do	15.0
May 23	do	do	do	4.3
June 20	W. B. Clapp and W. V. Hardy.	do	do	2.0
July 23	E. C. La Rue	do	do	1.5
Aug. 20	do	do	do	1.6
Sept. 20	W. B. Clapp	do	do	2.8
Sept. 28	E. C. La Rue	do	do	3.6
Oct. 22	do	do	do	5.6
Nov. 19	do	do	do	8.3
Dec. 10	do	do	do	8.7

Weir measurements of San Antonio Creek at division dam, California, 1889–1891.

[Measurements by F. E. Trask.]

Date.	Discharge.	Date.	Discharge.
1889.	*Second-feet.*	1890.	*Second-feet.*
July 15	20.56	August 1	32.08
August 1	18.00	August 15	26.76
August 15	16.40	September 1	22.14
September 2	16.24	September 15	18.92
September 16	13.96	1891.	
October 1	13.32	July 15	20.10
October 17	13.94	August 1	16.67
November 2	23.70	August 15	16.26
December 2	33.02	September 13	12.26
1890.			
July 15	37.71		

Weir measurements at San Antonio Creek at division box, California, 1892–1903.

[Measurements by F. E. Trask.]

Date.	Discharge.	Date.	Discharge.
1892.	*Second-feet.*	1897.	*Second-feet.*
July 15	12.50	September 20	9.24
September 15	8.16	1898.	
November 19	7.09	July 5	5.24
1893.		August 1	4.72
August 14	14.30	September 5	4.24
August 30	12.72	1899.	
September 25	12.16	July 3	2.98
October 25	10.84	August 7	3.88
1894.		September 3	4.06
July 16	6.00	1900.	
1895.		July 1	4.36
July 15	18.48	August 6	3.54
August 22	16.78	September 1	3.22
September 7	14.20	1902.	
1896.		July 21	5.30
June 25	6.58	August 16	4.22
July 15	5.20	September 13	3.40
September 15	5.44	1903.	
1897.			
July 6	17.24	August 10	9.40
August 16	10.82	August 16	7.66

July 18, 1888, float measurement by F. E. Trask showed 22.12 second-feet discharge for entire creek above division. (Excludes Gurd water=0.4 second-feet. Gurd water purchased by the San Antonio Water Company, May, 1896, and diverted above division weir.)

Discharge measurements of San Antonio tunnel at the Portal, California, 1888–1904.

[Measurements by F. E. Trask.]

Date.	Discharge.
	Second-feet.
1888.	
April 2	4.84
April 15	2.32
October 10	.73
1889.	
January 10	1.61
May 31	1.33
June 17	1.26
July 15	.91
August 15	.61
September 2	.61
October 1	.57
November 2	.86
December 2	.81
1890.	
January 27	5.58
June 12	2.57
July 15	2.49
August 15	2.23
September 15	1.36
1891.	
July 15	4.93
August 15	3.55
September 15	2.74
1892.	
July 16	3.49
September 15	2.98
1893.	
July 15	5.03
1894.	
May 11	2.72
July 16	2.75
1895.	
July 15	1.79
August 22	1.53
September 7	1.45
1896.	
June 25	1.62
July 15	1.52
September 15	1.19
1897.	
January 25	1.93
July 19	2.08
August 2	1.72
September 6	1.32
1897.	
October 4	1.19
1898.	
March 16	1.30
April 4	1.30
May 4	1.21
June 6	1 42
July 5	1.23
August 1	1.12
September 5	1.06
October 2	.97
November 6	1.02
December 5	1.05
1899.	
January 3	1.08
May 1	1.09
July 3	.97
August 7	.95
December 31	1.24
1900.	
February 1	1.14
March 5	1.07
April 1	1.01
May 7	1.00
July 1	1.00
October 8	1.00
1902.	
June 28	1.35
July 5	1.32
August 2	1.19
September 6	1.14
October 4	1.08
1903.	
January 19	.92
March 16	1.29
April 24	4.86
July 29	1.51
August 24	1.25
October 6	.99
December 1	1.07
1904.	
January 22	1.07
February 8	1.07
April 6	2.32
May 28	1.60
June 4	1.47

Natural flow of return water to Santa Ana River, in second-feet, compared with developed water in San Bernardino Valley above Colton, Cal., 1903–4.

[Measurements by K. Sanborn, engineer Riverside Water Company.]

Date.	Location.	Developed.	Natural.	Total.
		Second-ft.	*Second-ft.*	*Second-ft.*
1903.				
September 9	Brown tract, artesian well	0.11		0.11
September 4	Barnhill pumping plant	.80		.80
1904.				
May 12	Barnhill pumping plant	.85		.85
August 15	do	.77		.77
1903.				
September 4	Bloomington pumping plant	8.82		8.82
1904.				
May 12	Bloomington pumping plant	.00		.00
August 17	do	5.61		5.61
1903.				
August 17	Beam ditch		0.08	.08
1904.				
June 4	Beam ditch		.02	.02
August 20	do		.00	.00
1903.				
September 4	City of Colton pumping plant	3.17		3.17
1904.				
May 12	City of Colton (total all pumps)	3.00		3.00
August 19	do	2.06		2.06
1903.				
September 7	Cooley tract, artesian well	2.70		2.70
August 22	Camp Carlton ditch	2.20		2.20
1904.				
June 4	Camp Carlton ditch	2.50		2.50
August 19	do	2.60		2.60
1903.				
September 9	Daley ditch		.00	.00
1904.				
June 4	Daley ditch		.00	.00
August 20	do		.00	.00
1903.				
August 18	Flume pump No. 1, Riverside Water Co.	4.08		4.08

Natural flow of return water to Santa Ana River, in second-feet, etc.—Continued.

Date.	Location.	Developed.	Natural.	Total.
1904.		*Second-ft.*	*Second-ft.*	*Second-ft.*
May 31	Flume pump No. 1, Riverside Water Co.	1.79	.....	1.79
July 29	.....do	2.99	.....	2.99
1903.				
August 18	Flume pump No. 2, Riverside Water Co.	2.63	.....	2.63
1904.				
May 31	Flume pump No. 2, Riverside Water Co.	1.76	.....	1.76
July 29	.....do	2.52	.....	2.52
1903.				
September 9	Garner tract, artesian well	.77	.....	.77
August 21	Gage canal diversion	.....	0.00	.00
1904.				
May 31	Gage canal diversion	.....	.00	.00
August 15	.....do	.....	.00	.00
1903.				
August 21	Gage canal, Palm avenue weir	30.82	.....	30.82
1904.				
May 31	Gage canal, Palm avenue weir	27.80	.....	27.80
August 19	.....do	31.96	.....	31.96
1903.				
September 9	Hurd tract, artesian wells	.21	.....	.21
September 4	H. T. Hunter pumping plant	1.79	.....	1.79
1904.				
June 2	H. T. Hunter pumping plant	1.82	.....	1.82
August 17	.....do	1.54	.....	1.54
1903.				
August 17	Haws & Talmadge ditch	.....	.00	.00
1904.				
May 13	Haws & Talmadge ditch	.....	.00	.00
August 15	.....do	.....	.00	.00
1903.				
September 4	Johnson & Hubbard pumping plant	.42	.....	.42
1904.				
June 2	Johnson & Hubbard pumping plant	.67	.....	.67
August 17	.....do	.39	.....	.39
1903.				
September 4	Lawson Well Co. pumping plant	.59	.....	.59

Natural flow of return water to Santa Ana River, in second-feet, etc.—Continued.

Date.	Location.	Developed.	Natural.	Total.
1904.		*Second-ft.*	*Second-ft.*	*Second-ft.*
June 12	Lawson Well Co. pumping plant	0.65		0.65
August 15	do	.50		.50
1903.				
September 4	Lamb pumping plant	.24		.24
1904.				
May 12	Lamb pumping plant	.25		.25
August 15	do	.25		.25
1903.				
August 22	Logsden & Farrell ditch		0.00	.00
1904.				
June 4	Logsden & Farrell ditch		.00	.00
August 3	do		.00	.00
1903.				
September 1	Meeks & Daley ditch		12.87	12.87
1904.				
May 31	Meeks & Daley ditch		16.30	16.30
August 3	do		16.75	16.75
1903.				
September 9	McIntyre ditch		.00	.00
1904.				
August 15	McIntyre ditch		.00	.00
1903.				
August 17	McKenzie ditch		.00	.00
1904.				
May 13	McKenzie ditch	.67		.67
August 12	do	.58		.58
1903.				
August 18	Riverside Water Co., mill flume		.00	.00
1904.				
May 31	Riverside Water Co., mill flume		2.68	2.68
July 29	do		.00	.00
1903.				
September 4	Orange Land and Water Co	1.08		1.08
1904.				
May 12	Orange Land and Water Co	1.14		1.14
August 17	do	1.12		1.12

Natural flow of return water to Santa Ana River, in second-feet, etc.—Continued.

Date.	Location.	Developed.	Natural.	Total.
		Second-ft.	*Second-ft.*	*Second-ft.*
1903.				
September 7	Rancheria pumping plant	1.09		1.09
1904.				
May 12	Rancheria pumping plant	1.46		1.46
August 17	do	1.30		1.30
1903.				
September 1	Riverside Water Co., upper canal	23.89	32.01	55.90
1904.				
May 31	Riverside Water Co., upper canal	29.44	12.96	42.40
July 29	do	19.85	18.28	38.13
1903.				
September 4	Riverside Highland Water Co.'s pumping plant, Lytle Creek.	8.98		8.98
1904.				
May 12	Riverside Highland Water Co.'s pumping plant, Lytle Creek.	7.92		7.92
August 17	do	2.00		2.00
May 12	Riverside Highland Water Co., Santa Ana River.	.00		.00
August 19	do	6.43	.42	6.85
1903.				
August 17	Rabel dam ditch		.00	.00
1904.				
May 13	Rabel dam ditch		.00	.00
August 15	do		.00	.00
1903.				
August 19	River ditch pump, Riverside Water Co.	5.79		5.79
1904.				
May 21	River ditch pump (pumps Nos. 1 and 2)	9.33		9.33
August 23	River ditch pump	9.14		9.14
1903.				
August 19	C. W. Rogers pumping plant	4.44		4.44
1904.				
May 31	C. W. Rogers pumping plant	.00		.00
August 15	do	.00		.00
1903.				
August 17	Shay & Stout ditch	.00		.00
1904.				
May 13	Shay & Stout ditch	.00		.00
August 15	do	.00		.00

Natural flow of return water to Santa Ana River, in second-feet, etc.—Continued.

Date.	Location.	Developed.	Natural.	Total.
1903.		*Second-ft.*	*Second-ft.*	*Second-ft.*
September 7	Swamp ditch		0.42	0.42
1904.				
June 4	Swamp ditch		.51	.51
August 12	do		.47	.47
1903.				
September 9	Wozencraft tract, artesian well	0.23		.23
August 22	Whitlock ditch		.00	.00
1904.				
June 4	Whitlock ditch		.00	.00
August 20	do		.00	.00
1903.				
August 21	Ward & Warren ditch	1.44	.17	1.61
1904.				
June 4	Ward & Warren ditch		.00	.00
August 20	do		.00	.00
1903.				
August 17	Whiting ditch		.00	.00
1904.				
June 4	Whiting ditch		.00	.00
August 20	do		.00	.00
1903.				
August 19	West Riverside, 350-Inch Water Co	3.41		3.41
1904.				
May 21	West Riverside, 350-Inch Water Co	6.52		6.52
August 19	do	5.35		5.35
May 12	Merryfield pumping plant	.90		.90
August 5	do	.80		.80
May 12	Grand Terrace Pumping Co. pumping plant.	.34		.34
August 17	do	.34		.34
May 31	Riverside Water Co. mill pump, Colton	1.32		1.32
July 29	do	1.38		1.38
May 31	City of San Bernardino	.82	1.87	2.69
August 17	do	1.02	1.79	2.81
May 21	Rosedale Water Co	.60		.60
August 12	do	.50		.50
August 12	Carr pumping plant	.72		.72
August 17	Lytle Creek Water and Improvement Co.	4.00		4.00
May 21	Mount Vernon Water Co		.91	.91
August 17	do		.91	.91

Return waters in San Bernardino Valley below Slover Mountain and above Riverside Narrows, 1903 and 1904.

[Measurements by K. Sanborn, engineer Riverside Water Company.]

Date.	Location.	Developed.	Natural.	Total.
		Second-ft.	*Second-ft.*	*Second-ft.*
1903.				
August 20	Alvitriz ditch at intake, West Riverside Bridge.	.....	3.10	3.10
1904.				
May 13	Alvitriz ditch at intake, West Riverside Bridge.	.....	1.63	1.63
August 8	do	.....	2.23	2.23
1903.				
August 21	Evans ditch No. 1 at intake, Riverside County line.	.....	.81	.81
1904.				
May 16	Evans ditch No. 1 at intake, Riverside County line.	.....	2.53	2.53
August 11	do	.....	.00	.00
1903.				
August 22	Evans ditch No. 2 at intake, 1 mile below Riverside County line.	.....	.70	.70
1904.				
May 16	Evans ditch No. 2 at intake, 1 mile below Riverside County line.	.....	2.03	2.03
August 11	do	.....	1.31	1.31
1903.				
August 20	Evans Island ditch under west end of West Riverside Bridge.	.....	4.71	4.71
1904.				
May 13	Evans Island ditch under west end of West Riverside Bridge.	.....	3.43	3.43
August 8	do	.....	.00	.00
June 2	Evans well ditch, Santa Ana street	0.51	.....	.51
August 8	do	.04	.....	.04
June 3	Evans pipe line to Chino Gardens, at headworks.	.....	1.41	1.41
August 8	do	.....	.00	.00
August 8	Evans pumping plant, 1,000 feet south of west end of West Riverside Bridge.	3.03	.....	3.03
August 18	Evans Jurupa pumping-plant weir, end of force main.	2.00	.....	2.00
1903.				
August 21	Lower canal Riverside Water Co., at head.	.....	2.05	2.05
1904.				
May 21	Lower canal Riverside Water Co., at head.	.....	3.15	3.15
August 11	do	.....	.39	.39

Return waters in San Bernardino Valley below Slover Mountain, etc.—Continued.

Date.	Location.	Developed.	Natural.	Total.
1903.		*Second-ft.*	*Second-ft.*	*Second-ft.*
August 21	Rubidoux canal at head	1.74	4.78	6.52
1904.				
May 16	Rubidoux canal at head		6.49	6.49
August 8	do		2.82	2.82
June 3	Ferris Gallagher ditch near head		1.72	1.72
August 8	do		1.71	1.71
June 3	Gallagher ditch near headworks		.86	.86
August 18	do		.92	.92
August 18	Cuttle's pumping-plant weir at end of force main.	2.45		2.45
June 3	Jurupa pumping plant to supply Rubidoux ditch.	.00		.00
August 11	do	4.35		4.35
May 16	Riverside Power Co.'s canal near River Narrows.		38.30	38.30
August 18	do		29.50	29.50
August 8	Soquel ditch		1.49	1.49
August 8	Spanishtown pumping-plant weir at end of force main.	3.22		3.22
August 8	Spring Brook pumping-plant weir at end of force main.		4.84	4.84
June 3	Zimmerman pipe line at intake, near dam.		.00	.00
August 8	do		1.08	1.08
1903.				
August 25	Santa Ana River at Narrows		40.70	40.70

SAN FRANCISCO BAY DRAINAGE BASIN.

Sacramento River, rising in northern California and flowing south, and San Joaquin River, rising in the southern Sierras and flowing northeast, drain the western slope of the Sierra Nevada, traverse what is often called the Valley of California, and meet near Suisum Bay, finally discharging their waters into the Pacific Ocean through San Francisco Bay.

Sacramento River derives its water supply largely from Mount Shasta and the surrounding high ranges in the extreme northern portion of California. The stream does not have the same regular annual fluctuations that characterize the rivers discharging from the higher Sierra Nevada, since a large part of its basin is not at an elevation sufficient to cause the winter snows to remain unmelted until the sum-

mer months. The greatest floods of this basin usually occur in January and February, when the snow is accompanied or followed by rain.

San Joaquin River is divided into two distinct parts. The valley portion forms the central drainage line of San Joaquin Valley, and during the spring is navigable for a hundred miles or more. Stanislaus, Tuolumne, and King rivers are the largest affluents of this portion of the stream. Its valley is fertile and almost destitute of timber. The mountainous portion of the stream drains the western slopes of the Sierra Nevada between Yosemite National Park and Mount Goddard, the crest of its divide reaching on the north an elevation of 13,000 feet in Mount Lyell, and an elevation of 14,000 feet in Mount Goddard. The resulting steep grades of this river offer exceptional opportunities for water-power developments, and the high elevations of the basin insure a well-sustained summer flow from perpetual snow banks.

The following streams are tributary to either Sacramento or San Joaquin rivers:

Cache Creek is the outlet of Clear Lake, in Lake County, Cal. Flowing southeasterly, its flood waters find their way into Sacramento River between the mouths of Feather and American rivers. In 1889 Clear Lake was segregated as a reservoir site, as described in the Thirteenth Annual Report, part 3, pages 405–409. During 1900 a hydrographic examination of the entire basin of Cache Creek was made by A. E. Chandler, whose detailed report has been published as Water-Supply Paper No. 45.

Feather River is the second largest tributary of Sacramento River, Pit River being the first. Its basin line follows the crest of the Sierra Nevada for about 130 miles. The rainfall in this basin is large: the mean for nineteen years at Mumfords Hill, Plumas County, is 71.64 inches; the rainfall for the year 1889–90 at this point reached 138.85 inches. The water collected by the river when rains are general sometimes causes tremendous freshets, usually of short duration. The river has at such times overtopped its right bank and overflowed the plain lands to the north of Sutter Buttes. This occurred even before the great reduction of waterway below the mouth of Yuba River. The channel of the river below its junction with the Yuba has become the repository of so much mining débris that its bed has become nearly filled. Its bottom is almost at the heights of its former banks, and levees have been built to prevent overflowing. Only a comparatively small portion of the summer flow of this stream is used for irrigation, though the possibilities of irrigation and power development are great.

There are some excellent reservoir sites on the upper tributaries of the North Fork of the Feather. This stream is fed in part by large

springs, one of which, in Big Meadows, was flowing 109 cubic feet per second in September, 1902, and another 64 cubic feet per second.

Stony Creek drains 760 square miles of the eastern slopes of the Coast Range. After reaching the Sacramento Valley it flows north for a number of miles, contrary to the general drainage, and then turns east and enters Sacramento River below Vina, Cal. A large portion of the basin near the heads of the stream is heavily covered with commercial timber. There are a number of good reservoir sites on this stream and its tributaries.

Tuolumne River rises on the western slope of the Sierra Nevada in California and drains the country between Stanislaus River on the north and Merced River on the south. The northern half of Yosemite National Park includes a portion of the drainage basin of this stream. The river is fed largely from small mountain lakes occurring high in the drainage basin, where the snow remains on the mountain slopes throughout the year, thus insuring a large run-off. The stream has a heavy fall, and the opportunities for power development are numerous. There are also a number of reservoir sites in the basin where flood water could be stored for use during the irrigation season. The Tuolumne is an important tributary of the San Joaquin.

Merced River above Merced Falls drains approximately 1,090 square miles of the western slopes of the Sierra Nevada. There are included in the eastern portion of its drainage area a large number of high peaks, the highest, Mount Lyell, reaching an elevation of 13,042 feet. Its basin lies south of that of the Tuolumne, the courses of the two streams being nearly parallel.

King River rises on the western slope of the Sierra Nevada, in Fresno County, Cal. The waters coming from the high catchment basin are probably of greater value for irrigation purposes than those of any other stream in central California, being used for raising grapes and deciduous fruits in the neighborhood of Fresno, Selma, and Hanford. The summer flow of the river is now entirely diverted, and during the dry season of the last few years the scarcity of water has caused many hardships. In the spring there is a large surplus, due to the melting of snows, which, if stored in suitable reservoirs, would bring larger areas under cultivation. The river has a relatively gentle grade, affording little opportunity for power development.

Tule River drains a portion of the western slope of the Sierra Nevada. Its basin has somewhat less run-off than that of Kaweah River, which joins it on the north, and is much less elevated and snow-covered than King River basin. The water of this stream is all appropriated during the irrigation season, and a portion is used in irrigating valuable orange lands in the vicinity of Portersville, Cal.

Kern River flows from the southern end of the Sierra Nevada, being formed by two large tributaries, known as North and South forks.

These have a general southerly and parallel course and unite a short distance below the town of Kernville. The run-off from the drainage basin as a whole is notably less than that from the catchment areas to the north. This is probably due to the fact that a portion of the basin is to the east of the high crest, and is sheltered by the mountain mass from the rain-bearing winds. The waters of Kern River are almost completely used for irrigation by the large canals in the southern end of the San Joaquin Valley. The greater part of the land is included in large holdings owned by the Kern County Land Company or by the Miller and Lux estate. The winter waters are in part stored by the Miller and Lux estate in Buena Vista Lake, into which the river naturally discharges. The waters of this lake are controlled by a system of levees, so that they can be used during the following summer to irrigate lands lying to the northwest. This lake is very broad and shallow, and there is great loss by evaporation, so that as a matter of economy it would be desirable to hold this water in the upper mountain valleys. This would afford also a large supply for water power.

The fall of Kern River is sufficiently large for the development of a considerable amount of water power.

The following pages give the results of data collected in the San Francisco Bay drainage basin during 1904:

PUTA CREEK NEAR GUENOC, CAL.

This station was established on February 12, 1904. It is located about 1 mile below the town of Guenoc and at the Guenoc dam site. The gage is made of 2 by 6 inch plank, and is graduated to feet and tenths. There are two sections of the gage, both being fastened to trees. These gages are about 500 feet upstream from the station, and are read once a day at ordinary stages of the creek and twice each day, in times of high water, by Mrs. Irene Asbill, the observer. Discharge measurements are made from a car and cable. An auxiliary cable has been placed 150 feet downstream parallel to the large one, so that float measurements can be easily made in times of very high water. The initial point for soundings is the eyebolt to which the cable is fastened on the left bank. The channel is straight for 250 feet above and below the station. At ordinary and low-water stages the velocity is moderate. The left bank is high and is not subject to overflow. For gage readings above 20 feet the water spreads over a bench on the right side, but does not overflow the bank. The bed of the stream is composed of gravel and is not subject to any material change. The bench mark is a spike driven in the root of the tree to which the upper section of the gage is fastened, and its elevation is 16.44 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Puta Creek near Guenoc, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
February 12	S. G. Bennett	12.0	12,721
February 12	do	13.7	14,536
July 12	W. B. Clapp	3.62	14.7
August 22	do	3.50	9.5
November 15	O. W. Peterson	4.27	107

Mean daily gage height, in feet, of Puta Creek near Guenoc, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	5.70	5.65	4.60	3.90	3.70	(3.60)	(3.50)	3.60	3.70	3.90
2	.....	.....	5.55	5.45	4.50	(3.90)	3.70	3.60	3.50	3.60	3.70	4.00
3	.....	.....	5.35	5.35	4.50	3.90	3.70	3.60	3.50	3.60	3.80	4.00
4	.....	.....	5.15	5.20	4.50	3.90	(3.70)	(3.60)	3.50	3.60	3.80	4.10
5	.....	.....	5.10	5.10	4.40	3.90	3.70	3.60	3.50	3.50	3.80	4.10
6	.....	.....	5.05	5.00	4.40	(3.90)	3.70	(3.60)	3.50	3.50	3.90	4.10
7	.....	.....	5.15	4.90	4.30	(3.90)	(3.70)	3.60	3.50	3.50	3.90	4.00
8	.....	.....	5.45	4.80	4.30	3.90	3.70	(3.60)	3.50	3.70	3.80	4.00
9	.....	.....	5.35	4.80	4.30	3.80	3.70	3.50	(3.50)	4.70	3.80	3.90
10	.....	.....	16.65	4.70	4.20	3.80	3.60	(3.50)	3.50	5.40	3.80	3.90
11	.....	.....	8.00	4.70	4.20	(3.80)	3.60	(3.50)	3.50	5.00	3.80	3.90
12	.....	9.20	6.45	4.60	4.20	3.80	(3.60)	3.50	(3.50)	4.50	3.80	3.90
13	.....	6.50	5.85	4.60	4.20	(3.80)	3.60	3.50	3.50	4.30	3.80	4.00
14	.....	5.80	7.20	4.70	4.20	3.80	3.60	(3.50)	3.50	4.20	3.80	4.00
15	.....	14.40	6.20	4.70	4.10	3.70	(3.60)	(3.50)	3.50	4.20	4.20	4.00
16	.....	9.10	5.65	4.60	4.10	3.70	3.60	(3.50)	3.50	4.20	4.10	3.90
17	.....	6.60	9.70	4.60	4.10	3.70	3.60	(3.50)	3.50	4.20	4.00	3.90
18	.....	5.85	7.85	(5.10)	4.10	(3.70)	3.60	(3.50)	3.50	4.20	4.00	3.90
19	.....	5.50	8.75	5.60	4.00	3.70	3.60	(3.50)	3.50	4.10	4.00	4.00
20	.....	5.25	6.90	5.10	4.00	3.70	3.60	(3.50)	3.50	4.10	3.90	4.00
21	.....	5.30	6.20	4.80	4.00	3.70	3.50	(3.50)	3.50	4.10	3.90	4.00
22	.....	6.95	6.00	4.80	4.00	3.70	3.60	3.50	3.50	4.00	3.90	4.10
23	.....	5.75	6.35	4.70	4.00	(3.70)	3.60	3.50	3.50	4.00	3.90	4.10
24	.....	13.35	6.05	4.60	4.00	(3.70)	3.60	(3.50)	3.80	3.90	3.80	4.10
25	.....	6.85	5.80	4.60	4.00	3.70	(3.60)	3.50	3.90	3.90	3.80	4.10
26	.....	9.25	5.95	4.70	(4.00)	3.70	(3.60)	3.50	3.80	3.80	3.80	4.20
27	.....	7.45	6.80	4.70	(4.00)	(3.70)	3.60	3.50	3.60	3.80	3.80	4.20
28	.....	6.25	9.10	4.80	4.00	(3.70)	3.60	3.50	3.60	3.80	3.80	4.20
29	.....	6.00	7.25	4.70	4.00	3.70	3.60	(3.50)	(3.60)	3.80	3.80	4.20
30	.....	.....	6.25	4.60	4.00	3.70	3.60	3.50	3.60	3.80	3.90	12.75
31	.....	.....	5.85	.....	4.00	.....	3.60	3.50	.....	3.70	.....	11.25

NOTE.—Gage heights in parenthesis are estimated.

Rating table for Puta Creek near Guenoc, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.50	9.5	5.00	310	6.50	1,200	9.00	5,000
3.60	14	5.10	350	6.60	1,300	9.20	5,400
3.70	22	5.20	400	6.70	1,400	9.40	5,800
3.80	34	5.30	450	6.80	1,500	9.60	6,230
3.90	47	5.40	500	6.90	1,600	9.80	6,690
4.00	60	5.50	550	7.00	1,700	10.00	7,150
4.10	75	5.60	600	7.20	1,950	10.50	8,300
4.20	90	5.70	660	7.40	2,200	11.00	9,450
4.30	110	5.80	720	7.60	2,490	11.50	10,600
4.40	130	5.90	780	7.80	2,800	12.00	11,800
4.50	155	6.00	840	8.00	3,120	13.00	14,200
4.60	180	6.10	900	8.20	3,440	14.00	16,700
4.70	205	6.20	960	8.40	3,800		
4.80	240	6.30	1,040	8.60	4,200		
4.90	275	6.40	1,120	8.80	4,600		

Estimated monthly discharge of Puta Creek near Guenoc, Cal., for 1904.

[Drainage area, 91 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	60	60	[a] 60	3,689	0.66	0.76
February	17,700	60	2,515	144,664	27.64	29.81
March	23,325	330	2,168	133,305	23.18	27.46
April	630	180	279	16,602	3.07	3.43
May	180	60	89	5,472	.98	1.13
June	47	22	31	1,845	.34	.38
July	22	14	16	984	.18	.21
August	14	9.5	11	676	.12	.14
September	47	9.5	13	774	.14	.16
October	500	9.5	80	4,919	.88	1.01
November	90	22	42	2,499	.46	.51
December	13,600	47	821	50,481	9.02	10.40
The year	23,325	9.5	510	365,910	5.61	75.40

[a] Estimated.

Evaporation record of Clear Lake at Lakeport, Cal., 1901–1904.

[D. C. Rumsey, observer.]

Month.	1901. Evaporation in inches.		1902. Evaporation in inches.		1903. Evaporation in inches.		1904. Evaporation in inches.	
	Lake.	Land.	Lake.	Land.	Lake.	Land.	Lake.	Land.
January	0.85	.....	0.85	0.85	0.50	0.60	0.95	0.85
February	.95	.....	.25	.30	.80	.75	.35	.35
March	2.40	.....	1.60	1.55	.65	.65	.50	.50
April	3.05	.....	2.60	2.35	2.18	2.36	1.95	2.10
May	3.70	.....	4.00	3.70	5.12	5.74	4.60	5.05
June	3.95	.....	4.65	5.15	5.25	7.56	7.00	7.40
July	5.15	.....	6.65	7.40	6.33	8.37	7.45	8.60
August	5.00	.....	4.40	4.95	7.00	7.77	7.15	7.85
September	3.35	[a] 1.6	4.10	4.40	5.12	5.09	4.85	5.05
October	2.30	2.45	1.95	1.85	2.65	2.45	2.05	2.30
November	.85	1.05	.45	.45	1.07	1.05	1.25	1.35
December	1.30	.95	.40	.45	.92	.79	.75	.75
Annual	32.85	6.05	31.90	33.40	37.59	43.18	38.85	42.15

[a] September 15 to 29.

CACHE CREEK AT LOWER LAKE, CAL.

This station was established January 1, 1900, by S. G. Bennett. The original gage was located at the wagon bridge, from which discharge measurements were made. On March 26, 1903, a cable was installed 300 feet above the bridge, and a new gage was established 100 feet above the cable. The present gage is a vertical 1 by 3 inch plank nailed to a 6 by 6 inch timber driven into the bed of the river and fastened to a large willow tree on the left bank. On March 26, when the new gage was put in place, the reading was 5.7 feet. The old gage read 4.4 feet on the same date. The gage is read once each day by Mrs. J. R. Anderson. The initial point for soundings is a small tree in line with the cable on the left bank, 28 feet from the tree to which the cable is attached. The channel is straight for 150 feet above and for 300 feet below the station. The current has a moderate velocity at ordinary stages. The right bank is low and will overflow at a gage height of about 10 feet. It is covered with a thick growth of willow and oak trees for 100 feet back from the water's edge. The left bank is high and rocky and is not liable to overflow. The bed of the stream is composed of firm gravel and changes only slightly. Gravel is sometimes washed in from Siegler Creek, 300 feet below the cable. The bench mark is a nail in the root of the oak tree to which cable is fastened on the left bank. Its elevation is 8.32 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Cache Creek at Lower Lake, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 2	J. R. Anderson	3.50	194
January 9	do	3.60	206
January 16	do	3.60	210
January 23	do	3.70	238
January 31	do	3.70	239
February 6	do	3.80	250
February 12	do	4.48	277
February 13	do	4.30	363
February 21	do	5.30	633
February 24	do	7.58	281
February 27	do	7.40	1,108
March 5	do	7.90	1,286
March 12	do	10.50	2,412
March 19	do	11.40	2,759
March 23	do	11.60	3,275
March 26	do	11.50	3,009
March 28	do	12.00	2,700
April 17	do	10.50	2,631
April 24	do	10.00	2,363
May 2	do	9.50	2,008
May 7	do	8.80	1,774
May 14	do	8.20	1,550
May 20	do	7.20	1,238
May 28	do	6.55	1,026
June 4	do	6.15	924
June 11	do	5.80	842
June 18	do	5.60	780
June 27	do	5.30	678
July 4	do	5.10	598
July 9	do	4.85	500
July 16	do	4.70	473
July 23	do	4.50	419
July 30	do	4.35	407
August 6	do	4.20	359
August 13	do	4.10	325
August 21	W. B. Clapp	3.90	287
August 20	J. R. Anderson	3.90	282
August 27	do	3.80	260
September 3	do	3.60	231

Discharge measurements of Cache Creek at Lower Lake, Cal., in 1904—Continued.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
September 10	J. R. Anderson	3.55	201
September 17	do	3.45	180
September 24	do	3.35	160
October 1	do	3.40	166
October 8	do	3.30	149
October 15	do	3.50	191
October 23	do	3.40	168
October 30	do	3.40	164
November 5	do	3.30	145
November 13	do	3.25	137
November 20	do	3.30	142
November 26	do	3.20	128
December 4	do	3.25	129
December 11	do	3.25	122
December 17	do	3.30	130

Mean daily gage height, in feet, of Cache Creek at Lower Lake, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.50	3.70	7.80	12.10	9.50	6.30	5.15	4.30	3.70	3.40	3.30	3.30
2	3.50	3.70	7.90	12.10	9.40	6.25	5.15	4.25	3.65	3.40	3.30	3.30
3	3.50	3.70	7.95	12.00	9.30	6.30	5.10	4.25	3.65	3.40	3.30	3.30
4	3.60	3.80	7.95	11.90	9.20	6.15	5.10	4.20	3.60	3.35	3.30	3.25
5	3.55	3.75	[a]7.90	11.85	9.15	6.10	5.05	4.20	3.60	3.35	3.30	3.25
6	3.55	3.80	8.05	11.70	9.00	6.20	5.05	4.20	3.60	3.40	3.30	3.25
7	3.55	3.80	8.10	11.60	8.80	6.10	5.00	4.20	3.60	3.30	3.35	3.25
8	3.55	3.85	8.45	11.45	8.75	6.00	5.00	4.15	3.60	3.30	3.35	3.25
9	3.60	3.80	8.20	11.40	8.65	6.00	4.90	4.15	3.55	3.35	3.35	3.25
10	3.55	3.80	10.15	11.25	8.55	5.90	4.85	4.10	3.55	3.35	3.30	3.25
11	3.60	3.80	10.25	11.20	8.50	5.80	4.85	4.10	3.55	3.55	3.30	3.25
12	3.55	[a]4.55	[a]10.50	11.10	8.40	5.80	4.80	4.10	3.50	3.50	3.25	3.25
13	3.55	4.30	10.60	10.95	8.30	5.70	4.80	4.10	3.50	3.45	3.25	3.25
14	3.60	4.40	10.75	10.80	8.20	5.70	4.80	4.05	3.50	3.40	3.35	3.30
15	3.60	5.10	10.80	10.75	8.10	5.70	4.75	4.05	3.50	3.50	3.30	3.30
16	3.60	5.00	10.75	10.60	7.90	5.65	4.70	4.00	3.45	3.50	3.25	3.30
17	3.70	5.00	11.00	10.50	7.70	5.60	4.65	4.00	3.45	3.45	3.25	3.30
18	3.65	5.05	11.20	10.35	7.70	5.55	4.65	4.00	3.40	3.45	3.25	3.30
19	3.70	5.10	[a]11.40	10.50	7.40	5.50	4.60	3.90	3.40	3.45	3.25	3.30
20	3.70	5.20	11.65	10.45	7.25	5.50	4.60	3.90	3.40	3.40	3.25	3.30
21	3.70	5.30	11.55	10.25	7.10	5.50	4.55	3.90	3.40	3.40	3.25	3.30
22	3.70	5.45	11.60	10.30	7.00	5.50	4.55	3.90	3.40	3.40	3.25	3.30
23	3.70	5.60	11.60	10.10	6.90	5.40	4.50	3.85	3.40	3.40	3.25	3.30
24	3.70	[a]7.10	11.80	10.00	6.90	5.35	4.50	3.85	3.35	3.40	3.25	3.40
25	3.70	6.45	11.65	9.85	6.80	5.35	4.50	3.80	3.45	3.35	3.20	3.30
26	3.70	[a]7.40	[a]11.50	9.85	6.70	5.30	4.50	3.80	3.45	3.35	3.20	3.30
27	3.70	7.40	11.60	9.70	6.65	5.30	4.45	3.80	3.45	3.35	3.30	3.30
28	3.70	7.60	[a]12.80	9.70	6.55	5.25	4.45	3.80	3.45	3.35	3.30	3.25
29	3.70	7.70	12.00	9.60	6.50	5.20	4.40	3.75	3.40	3.35	3.30	3.30
30	3.70	.....	12.00	9.55	6.50	5.20	4.35	3.75	3.40	3.40	3.35	5.30
31	3.70	.....	12.00	.....	6.40	.....	4.30	3.70	.....	3.35	.....	4.10

[a] Gage height increased by backwater. Rating table not used. Discharge for day determined by meter measurement.

Rating table for Cache Creek at Lower Lake, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.20	126	4.70	475	6.20	910	8.40	1,640
3.30	147	4.80	500	6.30	940	8.60	1,710
3.40	168	4.90	525	6.40	970	8.80	1,780
3.50	189	5.00	550	6.50	1,000	9.00	1,850
3.60	210	5.10	580	6.60	1,030	9.20	1,930
3.70	231	5.20	610	6.70	1,060	9.40	2,010
3.80	253	5.30	640	6.80	1,090	9.60	2,100
3.90	276	5.40	670	6.90	1,120	9.80	2,200
4.00	300	5.50	700	7.00	1,150	10.00	2,300
4.10	325	5.60	730	7.20	1,220	10.50	2,600
4.20	350	5.70	760	7.40	1,290	11.00	2,900
4.30	375	5.80	790	7.60	1,360	11.50	3,250
4.40	400	5.90	820	7.80	1,430	12.00	3,600
4.50	425	6.00	850	8.00	1,500		
4.60	450	6.10	880	8.20	1,570		

Estimated monthly discharge of Cache Creek at Lower Lake, Cal., for 1904.

[Drainage area, 500 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1904.						
January	231	189	216	13,281	0.43	0.50
February	1,395	231	541	31,119	1.08	1.16
March	3,600	1,286	2,588	159,130	5.18	5.97
April	3,680	2,075	2,801	166,671	5.60	6.25
May	2,050	970	1,460	89,772	2.92	3.37
June	940	610	762	45,342	1.52	1.70
July	595	375	483	29,699	.97	1.12
August	375	231	302	18,569	.60	.69
September	231	158	188	11,187	.38	.42
October	200	147	168	10,330	.34	.39
November	158	126	143	8,509	.29	.32
December	640	136	165	10,145	.33	.38
The year	3,680	126	818	593,754	1.64	22.27

CACHE CREEK NEAR YOLO, CAL.

This station was established January 1, 1903, by S. G. Bennett. It is located at the wagon bridge on the road from Woodland to Yolo, about 1,000 feet above the Southern Pacific Railway bridge. The gage is a 2 by 12 inch vertical plank nailed to the upstream side of the right abutment. It is read twice each day by John Woodard. Discharge measurements are made from the downstream side of the bridge, to which the gage is attached. The initial point for soundings is the end of the bridge on the right bank. The channel is straight for 1,000 feet above and below the station. The current is swift at ordinary and high stages. The banks are steep and wooded and their height has been increased by levees. They are said to overflow at extreme high water. The bed of the stream is composed of earth and gravel, with a little sand, and is not subject to any material change. On December 4, 1904, this station was reestablished by O. W. Peterson. A new bridge which has been erected greatly improves the conditions. The gage is in four sections, three of which are above the bridge and the fourth is bolted to the face of the concrete abutment on the right bank. The gages are made of 3 by 8-inch timber, painted white and graduated to feet and tenths. The gage datum remains the same as before.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Cache Creek near Yolo, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 28	W. B. Newhall	2.40	283
February 10	F. W. Huber	2.50	371
February 16	do	14.25	8,770
February 17	do	9.65	4,782
February 17	do	8.25	4,124
February 18	do	6.35	3,514
February 19	do	5.55	2,772
March 11	S. G. Bennett	17.80	8,300
March 12	do	12.10	5,195
April 9	W. B. Newhall	8.20	3,714
June 17	O. W. Peterson	3.75	724
July 13	do	2.90	435
August 10	do	2.30	210
October 4	do	1.80	111
December 4	do	2.05	148
December 10	do	2.05	150

Mean daily gage height, in feet, of Cache Creek near Yolo, for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.10	2.30	7.85	9.70	6.50	4.30	3.00	2.20	1.50	(1.80)	2.00	2.15
2	2.10	2.35	7.30	9.45	6.40	4.20	3.00	2.20	1.50	1.80	2.00	2.10
3	2.10	2.45	7.05	9.15	6.35	4.15	3.00	2.10	1.50	1.80	2.00	2.10
4	2.10	2.50	6.85	8.90	6.30	4.10	2.95	2.10	1.50	1.80	1.90	2.05
5	2.10	2.60	6.65	8.65	6.20	4.00	2.90	2.10	1.50	1.80	1.90	2.05
6	2.10	2.60	6.45	8.45	6.15	3.95	2.90	2.00	1.50	1.80	1.90	2.05
7	2.10	2.60	6.35	8.30	6.05	3.90	2.90	2.00	1.50	1.70	1.90	2.05
8	2.10	2.55	6.30	8.20	6.00	3.80	2.90	2.00	1.50	1.70	1.90	2.05
9	2.10	2.50	6.20	8.10	5.85	3.75	2.80	2.00	1.50	1.70	1.90	2.05
10	2.10	2.50	14.75	8.00	5.80	3.70	2.80	1.90	1.50	3.00	1.90	2.05
11	2.10	2.50	20.75	7.90	5.70	3.60	2.80	1.90	[a](1.50)	5.05	1.80	2.05
12	2.10	5.95	12.00	7.80	5.65	3.55	2.80	1.90	(1.50)	4.10	1.80	2.15
13	2.10	9.25	10.75	7.70	5.60	3.50	2.70	1.90	(1.50)	3.45	1.80	2.15
14	2.10	5.50	10.60	7.60	5.50	3.50	2.70	1.80	(1.50)	3.00	1.80	2.15
15	2.10	5.25	10.50	7.50	5.40	3.50	2.65	1.80	(1.50)	2.65	1.80	2.10
16	2.10	16.75	10.40	7.40	5.35	3.40	2.60	1.80	(1.50)	2.45	1.70	2.10
17	2.10	8.75	11.65	7.40	5.30	3.40	2.60	1.70	(1.50)	2.30	1.70	2.10
18	2.10	7.00	16.50	7.30	5.20	3.40	2.60	1.70	(1.50)	2.30	1.70	2.10
19	2.50	5.80	11.75	7.20	5.15	3.40	2.55	1.70	(1.50)	2.20	1.70	2.10
20	2.40	5.10	10.55	7.10	5.10	3.30	2.50	1.70	(1.50)	2.20	1.70	2.10
21	2.40	4.90	10.25	7.00	5.00	3.30	2.50	1.70	(1.50)	2.20	1.70	2.10
22	2.40	11.00	10.10	6.90	4.95	3.30	2.40	1.70	(1.60)	2.10	1.70	2.10
23	2.40	14.75	11.00	6.85	4.90	3.20	2.40	1.70	(1.70)	2.10	1.70	2.15
24	2.30	16.50	9.80	6.80	4.80	3.20	2.40	1.70	(1.70)	2.10	1.90	2.15
25	2.30	7.50	9.80	6.80	4.75	3.20	2.40	1.70	(1.90)	2.10	1.90	2.15
26	2.30	13.00	9.65	6.70	4.70	3.20	2.35	1.70	(1.90)	2.10	1.90	2.10
27	2.30	16.50	9.50	6.70	4.60	3.10	2.30	1.70	(1.90)	2.10	1.90	2.10
28	2.30	9.60	16.75	6.60	4.55	3.10	2.30	1.70	(1.80)	2.00	1.90	2.10
29	2.30	8.60	14.50	6.60	4.50	3.10	2.30	1.60	(1.80)	2.00	2.20	2.05
30	2.20	.....	11.70	6.50	4.40	3.10	2.30	1.60	(1.80)	2.00	2.20	2.30
31	2.20	.....	10.40	.....	4.35	.....	2.20	1.60	.....	2.00	.....	15.20

[a] Gage destroyed. From September 11 to October 1 gage heights determined by comparison with those on Stony Creek.

Rating table for Cache Creek near Yolo, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.00	22	2.60	305	4.20	980	6.60	2,420
1.10	30	2.70	340	4.30	1,030	6.80	2,560
1.20	40	2.80	375	4.40	1,080	7.00	2,700
1.30	50	2.90	410	4.50	1,130	7.20	2,850
1.40	60	3.00	445	4.60	1,185	7.40	3,000
1.50	70	3.10	495	4.70	1,240	7.60	3,150
1.60	82	3.20	535	4.80	1,295	7.80	3,300
1.70	96	3.30	575	4.90	1,350	8.00	3,450
1.80	110	3.40	615	5.00	1,405	8.50	3,825
1.90	125	3.50	655	5.20	1,525	9.00	4,200
2.00	140	3.60	700	5.40	1,645	9.50	4,600
2.10	160	3.70	745	5.60	1,770	10.00	5,000
2.20	180	3.80	790	5.80	1,900	11.00	5,900
2.30	205	3.90	835	6.00	2,030	12.00	6,800
2.40	235	4.00	880	6.20	2,160	14.00	8,600
2.50	270	4.10	930	6.40	2,290	16.00	10,500

Estimated monthly discharge of Cache Creek near Yolo, Cal., for 1904.

[Drainage area, 1,280 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	270	160	183	11,252	0.14	0.16
February	11,250	205	3,166	182,110	2.47	2.66
March	15,250	2,160	5,591	343,777	4.37	5.04
April	4,760	2,355	3,188	189,699	2.49	2.78
May	2,355	1,055	1,656	101,824	1.29	1.49
June	1,030	495	681	40,522	.53	.59
July	445	180	316	19,430	.25	.29
August	180	82	117	7,194	.09	.10
September	125	70	82	4,879	.06	.07
October	1,435	96	254	15,618	.20	.23
November	180	96	120	7,140	.09	.10
December	9,700	150	469	28,838	.37	.43
The year	15,250	70	1,319	952,283	1.03	13.94

STONY CREEK NEAR FRUTO, CAL.

This station was established on January 30, 1901, by Burt Cole. It is located at Julian's ranch, 6 miles northwest of Fruto, and 1¾ miles above the proposed Mill Site dam. The gage is in two sections. The low-water gage, which is bolted to the rock, is a 2 by 8 inch plank and is graduated to feet and tenths. The high-water gage is a 6 by 6 inch timber painted white and graduated to feet and tenths. The gage is read twice each day by W. H. Julian. Discharge measurements are made from a car and cable. The initial point for soundings is the eye-bolt on the left bank to which the cable is attached. The channel is straight for 200 feet above and 200 feet below the cable. The current is very swift at high water and sluggish at low water. Neither bank is subject to overflow, but at high stages of the creek the water spreads to the right for several hundred feet. The bed of the stream is of gravel and is subject to some change. The bench mark is the head of an iron bolt set in the rock near the upper gage at an elevation of 14.00 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Stony Creek near Fruto, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 27	W. B. Newhall	4.25	321
February 10	F. W. Huber	4.2	293
February 18	W. B. Newhall	7.25	2,507
February 25	F. W. Huber	10.15	7,001
February 26	do	8.85	5,387
February 26	do	11.35	12,447
April 8	A. C. Lootz	6.6	2,050
April 8	do	6.6	2,009
April 9	do	6.6	1,943
April 10	do	6.5	1,986
April 11	do	6.5	2,069
June 15	O. W. Peterson	4.2	202
July 13	do	3.63	63
August 9	do	3.5	16
October 3	do	3.5	44

Mean daily gage height, in feet, of Stony Creek near Fruto, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.20	4.10	7.20	7.35	5.50	4.50	3.50	3.30	3.20	3.40	3.50	3.90
2	4.20	4.10	7.20	7.25	5.50	4.50	3.50	3.30	3.20	3.40	3.50	3.90
3	4.20	4.10	7.10	7.00	5.50	4.50	3.50	3.30	3.20	3.50	3.50	3.90
4	4.20	4.10	7.05	6.80	5.50	4.40	3.50	3.30	3.20	3.50	3.50	3.90
5	4.20	4.60	6.75	6.70	5.40	4.40	3.50	3.30	3.20	3.50	3.50	3.90
6	4.20	4.35	6.85	6.60	5.40	4.40	3.50	3.30	3.20	3.50	3.50	3.90
7	4.20	4.30	7.55	6.50	5.40	4.30	3.50	3.30	3.20	3.50	3.50	3.90
8	4.20	4.30	7.65	6.60	5.30	4.30	3.50	3.30	3.20	3.50	3.50	3.90
9	4.20	4.30	7.25	6.60	5.30	4.30	3.50	3.30	3.20	3.60	3.50	4.10
10	4.20	4.20	13.25	6.60	5.30	4.20	3.50	3.30	3.20	3.60	3.50	4.20
11	4.40	4.20	9.25	6.60	5.30	4.20	3.50	3.30	3.20	6.55	3.50	4.30
12	4.30	9.00	7.85	6.50	5.30	4.10	3.50	3.30	3.20	5.50	3.50	4.30
13	4.20	6.25	7.35	6.40	5.30	4.10	3.50	3.30	3.20	5.00	3.50	4.50
14	4.20	5.45	8.65	6.30	5.20	4.00	3.50	3.30	3.20	4.00	3.50	4.50
15	4.20	8.25	8.00	6.20	5.20	4.00	3.50	3.30	3.20	3.80	3.60	4.30
16	4.20	12.25	7.60	6.00	5.20	3.90	3.50	3.30	3.20	3.80	3.60	4.20
17	4.40	8.25	10.50	5.90	5.10	3.90	3.40	3.30	3.20	3.70	3.70	4.10
18	4.40	7.20	9.75	5.80	5.10	3.90	3.40	3.30	3.20	3.70	3.70	4.00
19	4.40	6.65	8.85	6.10	5.10	3.80	3.40	3.30	3.20	3.70	3.70	4.00
20	4.40	5.85	8.90	5.80	5.00	3.80	3.40	3.30	3.20	3.60	3.70	4.00
21	4.30	7.85	8.00	5.70	5.00	3.80	3.40	3.20	3.20	3.60	3.70	3.90
22	4.30	11.75	7.45	5.70	4.90	3.70	3.40	3.20	3.30	3.60	3.70	3.90
23	4.30	8.85	7.20	5.60	4.90	3.70	3.40	3.20	3.40	3.60	3.70	3.90
24	4.30	13.50	6.95	5.50	4.90	3.60	3.30	3.20	3.40	3.50	3.70	4.30
25	4.30	10.00	6.80	5.50	4.80	3.60	3.30	3.20	3.60	3.50	3.70	4.20
26	4.30	10.00	6.65	5.50	4.80	3.50	3.30	3.20	3.60	3.50	3.70	4.20
27	4.20	9.05	8.35	5.60	4.80	3.50	3.30	3.20	3.60	3.50	4.10	4.20
28	4.20	7.90	10.50	5.60	4.80	3.50	3.30	3.20	3.50	3.50	4.00	4.10
29	4.20	7.40	9.35	5.60	4.70	3.50	3.30	3.20	3.50	3.50	3.90	4.10
30	4.20	.....	8.55	5.60	4.70	3.50	3.30	3.20	3.40	3.50	3.90	9.35
31	4.20	.....	7.30	.....	4.60	.....	3.30	3.20	.....	3.50	.....	7.40

Rating table for Stony Creek near Fruto, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.20	9	4.80	500	6.30	1,680	8.60	4,600
3.30	16	4.90	560	6.40	1,780	8.80	4,930
3.40	30	5.00	620	6.50	1,880	9.00	5,270
3.50	45	5.10	685	6.60	1,980	9.20	5,630
3.60	60	5.20	755	6.70	2,090	9.40	6,000
3.70	80	5.30	830	6.80	2,200	9.60	6,400
3.80	100	5.40	905	6.90	2,310	9.80	6,800
3.90	120	5.50	980	7.00	2,420	10.00	7,280
4.00	150	5.60	1,060	7.20	2,660	10.50	8,560
4.10	180	5.70	1,140	7.40	2,900	11.00	10,200
4.20	210	5.80	1,220	7.60	3,150	11.50	12,200
4.30	250	5.90	1,310	7.80	3,410	12.00	14,200
4.40	300	6.00	1,400	8.00	3,690	12.50	16,700
4.50	350	6.10	1,490	8.20	3,980	13.00	19,200
4.60	400	6.20	1,580	8.40	4,280	13.50	22,200
4.70	450						

Estimated monthly discharge of Stony Creek near Fruto, Cal., for 1904.

[Drainage area, 760 square miles.]

Month.	Discharge in second-feet			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	300	210	234	14,388	0.31	0.36
February	22,220	180	3,800	218,578	5.00	5.39
March	20,700	2,035	4,364	268,332	5.74	6.62
April	2,840	980	1,604	95,445	2.11	2.35
May	980	400	715	43,964	.94	1.08
June	350	45	165	9,818	.22	.25
July	45	16	34	2,091	.04	.05
August	16	9	14	861	.02	.02
September	60	9	19	1,131	.02	.02
October	1,930	30	167	10,268	.22	.25
November	180	45	71	4,225	.09	.10
December	5,905	120	453	27,854	.60	.69
The year	22,220	9	970	696,955	1.28	17.18

SACRAMENTO RIVER NEAR RED BLUFF, CAL.

The gaging station at Jellys Ferry, which is located about 12 miles above the town of Red Bluff, was established April 30, 1895. The right bank of the river is high, but the left bank is liable to overflow when the river rises above the 25-foot mark. The river has been known to reach the 35-foot mark. Because of the liability to overflow it was deemed advisable to select a new gaging station where the water at flood stage would be more confined. A point in Iron Canyon, where the river had been gaged by the State engineering department in 1879 and by commissioner of public works in 1893–94, was chosen as a new gaging station. The river stage rod used by commissioner of public works was still in place and has been used in making river height observations since January 28, 1902, the date upon which the observations were begun. A second set of gage rods were placed on the right bank 3,200 feet below the gaging station January 1, 1904, as no observer could be obtained to continue readings of the station gage. By synchronous readings of the lower gages and the station gage the actual gage readings for this lower gage have been converted into equivalent readings for the station gage. Frank Wilcox read the gage once each day. On September 28, 1904, it was necessary to move the lower gage rods to the left bank about 4,000 feet below the gaging station. The actual readings of this set of gage rods have also been converted into

equivalent readings for the station gage. The gage is read twice each day by Fred Weeks. All reported gage heights are those determined for the station gage. The river at this point in lower portion of Iron Canyon, 4 miles above Red Bluff, has a direct course for 2 or 3 miles. The width between banks at low water is about 500 feet. The depth of water at low stages averages 6 feet, with a maximum depth of 9 feet. The banks are steep and firm. The river flows in a bed of coarse gravel and cobbles, with here and there a small bowlder. The bed rock is lava. Discharge measurements are made from a cable 600 feet in span, which is anchored in a lava rock which forms the wall of the canyon.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Sacramento River near Red Bluff, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 23	W. B. Newhall	3.15	10,584
February 8	F. W. Huber	2.8	10,674
February 17	S. G. Bennett	15.2	72,400
February 29	A. C. Lootz	12.3	57,381
March 30	S. G. Bennett	15.08	66,657
April 1	A. C. Lootz	11.75	44,429
April 1	do	11.6	43,843
April 2	A. Buffinger	10.55	42,759
April 2	A. C. Lootz	10.7	42,329
April 4	do	10.98	46,231
April 4	do	10.94	44,665
April 5	do	10.2	39,509
April 6	do	10.18	39,671
April 6	do	9.8	39,053
June 13	O. W. Peterson	3.72	12,450
July 15	do	2.25	7,846
August 10	W. B. Clapp	1.7	6,055
September 27	O. W. Peterson	2.15	7,460
December 7	do	2.48	8,055

Mean daily gage height, in feet, of Sacramento River near Red Bluff, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.60	2.80	13.10	11.90	8.50	5.05	2.80	2.20	1.50	1.70	2.20	3.75
2	3.50	2.50	15.55	10.50	8.40	4.80	2.80	2.20	1.50	1.55	2.70	3.15
3	3.40	2.40	14.40	10.70	8.30	4.70	2.80	2.05	1.50	1.65	2.50	2.95
4	3.40	2.30	15.80	10.70	8.20	4.50	2.80	2.05	1.50	1.65	2.20	2.80
5	3.15	2.50	14.70	10.60	8.05	4.40	2.80	2.05	1.50	1.65	2.20	2.70
6	3.00	3.30	13.10	10.50	7.95	4.30	2.80	1.90	1.50	1.55	2.20	2.55
7	2.90	3.30	16.30	10.10	7.75	4.30	2.70	1.90	1.50	1.70	2.20	2.50
8	3.40	3.30	24.40	9.90	7.60	4.20	2.70	1.90	1.50	2.15	2.20	2.50
9	3.40	3.30	18.95	9.80	7.50	4.30	2.65	1.90	1.50	4.10	2.20	2.60
10	3.40	3.30	17.90	9.65	7.40	4.20	2.65	1.80	1.50	7.45	2.20	3.15
11	3.40	3.30	15.80	9.60	7.30	3.95	2.65	1.80	1.50	11.20	2.15	2.75
12	3.15	3.30	14.70	9.65	7.20	3.85	2.65	1.80	1.50	7.25	2.15	3.25
13	3.00	6.30	13.30	9.65	7.10	3.75	2.65	1.80	1.50	4.60	2.15	3.85
14	2.90	6.30	15.80	9.80	7.00	3.60	2.65	1.80	1.50	3.80	2.15	3.65
15	2.80	17.35	17.25	9.90	6.90	3.60	2.65	1.80	1.50	4.15	2.75	3.25
16	3.00	[a]28.00	18.30	9.80	6.80	3.60	2.65	1.80	1.50	3.55	3.40	3.15
17	3.40	15.20	(18.85)	9.90	6.65	3.60	2.50	1.65	1.50	3.35	2.80	2.90
18	5.25	11.20	19.40	10.60	6.55	3.50	2.50	1.65	1.50	2.95	3.15	2.90
19	5.25	9.55	18.30	10.95	6.30	3.40	2.50	1.65	1.50	2.75	3.00	3.00
20	4.30	9.90	19.40	10.40	6.10	3.40	2.40	1.65	1.50	2.60	3.00	3.10
21	3.95	12.50	16.20	10.40	6.20	3.40	2.40	1.65	1.50	2.50	2.90	3.20
22	3.70	20.30	13.50	9.35	6.30	3.15	2.40	1.65	1.50	2.45	2.75	(2.90)
23	3.50	16.60	12.40	8.80	6.45	3.00	2.40	1.65	3.40	2.35	2.60	2.55
24	3.40	19.15	11.50	8.30	6.30	2.90	2.40	1.65	4.30	2.20	2.50	5.70
25	3.15	19.15	10.40	8.20	6.20	2.80	2.40	1.50	3.30	2.20	2.50	5.65
26	3.15	16.80	8.80	8.30	6.10	2.80	2.30	1.50	2.30	2.20	2.50	3.80
27	3.15	17.80	11.50	10.40	6.00	2.80	2.30	1.50	2.05	2.15	3.70	3.35
28	3.15	12.85	14.70	10.70	5.90	2.80	2.30	1.50	1.90	2.10	3.35	3.20
29	3.15	13.40	18.20	10.30	5.70	2.80	2.30	1.50	1.80	2.10	2.90	3.35
30	3.15	.....	14.80	8.80	5.60	2.80	2.30	1.50	1.80	2.15	3.70	12.50
31	3.00	.....	13.00	.....	5.50	.....	2.20	1.50	.....	2.30	.....	13.70

[a] Gage height 9 a. m. Highest known gage height 31.00 same night.

NOTE.—Gage heights in parenthesis are estimated.

Rating table for Sacramento River near Red Bluff, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.00	4,450	3.50	11,700	6.00	21,100	12.50	52,600
1.10	4,690	3.60	12,040	6.20	21,940	13.00	55,600
1.20	4,930	3.70	12,380	6.40	22,780	13.50	58,600
1.30	5,170	3.80	12,720	6.60	23,620	14.00	61,700
1.40	5,410	3.90	13,060	6.80	24,460	14.50	64,900
1.50	5,650	4.00	13,400	7.00	25,300	15.00	68,200
1.60	5,920	4.10	13,760	7.20	26,180	15.50	71,600
1.70	6,190	4.20	14,120	7.40	27,060	16.00	75,100
1.80	6,460	4.30	14,480	7.60	27,940	16.50	78,600
1.90	6,730	4.40	14,840	7.80	28,820	17.00	82,200
2.00	7,000	4.50	15,200	8.00	29,700	17.50	85,900
2.10	7,300	4.60	15,580	8.20	30,620	18.00	89,700
2.20	7,600	4.70	15,960	8.40	31,540	19.00	97,600
2.30	7,900	4.80	16,340	8.60	32,460	20.00	105,900
2.40	8,200	4.90	16,720	8.80	33,380	21.00	114,600
2.50	8,500	5.00	17,100	9.00	34,300	22.00	123,700
2.60	8,810	5.10	17,500	9.20	35,260	23.00	133,200
2.70	9,120	5.20	17,900	9.40	36,220	24.00	143,100
2.80	9,430	5.30	18,300	9.60	37,180	25.00	153,400
2.90	9,740	5.40	18,700	9.80	38,140	26.00	163,800
3.00	10,050	5.50	19,100	10.00	39,100	27.00	174,200
3.10	10,380	5.60	19,500	10.50	41,600	28.00	184,600
3.20	10,710	5.70	19,900	11.00	44,200		
3.30	11,040	5.80	20,300	11.50	46,900		
3.40	11,370	5.90	20,700	12.00	49,700		

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1902 to 1904, inclusive. It is well defined between gage heights 1 and 15 feet, and fairly well defined between gage heights 15 and 25 feet. The table has been extended beyond these limits. Above gage height 25 feet the rating curve is a tangent, the difference being 1,040 per tenth.

NOTE.—This table is for the gage at the station.

Estimated monthly discharge of Sacramento River near Red Bluff, Cal., for 1904.

[Drainage area, 9,295 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	18,100	9,430	11,489	706,431	1.24	1.43
February	184,600	7,900	46,346	2,665,852	4.99	5.38
March	100,880	33,380	73,281	4,505,873	7.88	9.08
April	49,140	30,620	38,906	2,315,068	4.19	4.67
May	32,000	19,100	25,080	1,542,109	2.70	3.11
June	17,300	9,430	12,362	735,590	1.33	1.48
July	9,430	7,600	8,656	532,237	.93	1.07
August	7,600	5,650	6,348	390,323	.68	.78
September	14,480	5,650	6,530	388,562	.70	.78
October	45,280	5,785	10,990	675,749	1.18	1.36
November	12,380	7,450	8,932	531,491	.96	1.07
December	59,840	8,500	13,875	853,141	1.49	1.72
The year	184,600	5,650	21,900	15,842,426	2.36	31.93

M'CLOUD RIVER NEAR GREGORY, CAL.

This station was established March 23, 1902, at the request of the consulting engineer of the McCloud River Electric Company, with the understanding that they would maintain the station. The watershed of McCloud River includes the southern and eastern slopes of Mount Shasta and is heavily timbered. The river is fed by the numerous springs and its minimum flow is about 1,100 second-feet. The gage rod is a 2 by 3 inch timber nailed and wired to a tree on the right bank of the stream at Johns Camp, 14 miles east of Gregory. Measurements are made from a car suspended from a wire cable. The initial point of sounding is at the gage rod on the right bank of the stream. The channel is straight for 300 feet above and for 600 feet below the gaging station. The current is swift at all stages. The banks are high and wooded and not liable to overflow. The bed is composed of limestone on the sides, with some large river gravel and bowlders in the center of the channel. Sufficient meter measurements have not been taken to construct a rating curve.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of McCloud River near Gregory, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 25	W. B. Newhall	1.85	1,900
August 8	W. B. Clapp	1.90	1,653
October 30	O. W. Peterson	1.75	1,600

Mean daily gage height, in feet, of McCloud River near Gregory, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.10	1.80	5.90	4.30	3.80	3.15	2.20	1.90	1.75	1.75	1.90	1.95
2	2.00	1.80	7.10	4.00	3.95	2.95	2.20	1.90	1.75	1.75	1.90	1.90
3	1.90	1.70	6.00	4.80	3.80	2.90	2.20	1.90	1.75	1.75	1.90	1.90
4	1.90	1.90	5.90	4.85	3.80	2.90	2.20	1.90	1.75	1.75	1.90	1.90
5	1.90	1.90	5.10	4.35	3.80	2.85	2.20	1.90	1.75	1.75	1.85	1.90
6	1.90	1.90	4.75	4.30	3.70	2.80	2.20	1.90	1.75	1.75	1.80	1.90
7	1.85	1.85	8.00	4.25	3.80	2.80	2.15	1.90	1.70	1.90	1.80	1.95
8	1.80	1.80	14.50	4.35	3.80	2.80	2.15	1.90	1.70	1.90	1.80	1.95
9	1.80	1.80	9.00	4.30	3.70	2.75	2.15	1.90	1.70	2.65	1.80	2.00
10	1.80	1.80	9.15	4.75	3.70	2.70	2.15	1.90	1.70	2.80	1.75	2.10
11	1.90	1.90	5.75	4.90	3.80	2.70	2.15	1.90	1.70	8.45	1.75	2.00
12	1.90	2.90	5.00	5.10	3.90	2.65	2.10	1.90	1.70	5.85	1.75	2.00
13	1.80	2.80	4.80	5.10	4.05	2.60	2.10	1.90	1.70	5.30	1.75	2.00
14	1.85	2.65	5.00	4.85	4.10	2.60	2.10	1.85	1.70	4.90	1.75	2.00
15	1.90	7.50	5.50	5.35	4.15	2.55	2.10	1.85	1.70	4.30	1.85	2.00
16	2.15	14.20	5.90	5.50	4.10	2.50	2.05	1.85	1.75	3.85	1.85	2.00
17	2.30	7.50	6.00	5.15	3.95	2.50	2.05	1.85	1.70	3.30	2.50	1.95
18	2.40	4.35	6.10	4.70	3.80	2.50	2.05	1.85	1.70	3.10	2.50	1.95
19	2.25	3.75	6.30	5.10	3.60	2.50	2.05	1.80	1.70	2.00	2.10	1.90
20	2.30	3.10	6.65	5.45	3.60	2.45	2.05	1.80	1.70	2.00	2.00	1.90
21	2.20	3.25	6.80	4.95	3.55	2.40	2.00	1.80	1.70	1.95	2.00	1.90
22	2.00	6.75	6.90	4.75	3.65	2.40	2.00	1.80	1.80	1.90	2.00	1.85
23	1.90	6.80	5.70	4.45	3.70	2.30	2.00	1.80	2.15	1.90	1.95	1.90
24	1.90	5.95	4.10	4.10	3.70	2.30	2.00	1.80	2.05	1.90	1.95	2.40
25	1.80	5.50	3.50	4.00	3.60	2.25	2.00	1.80	1.90	1.90	1.90	2.15
26	1.80	4.75	3.50	4.10	3.50	2.25	1.95	1.80	1.80	1.90	1.90	2.00
27	1.75	6.10	3.50	4.50	3.50	2.20	1.90	1.80	1.80	1.85	2.00	2.00
28	1.80	5.90	4.05	4.10	3.45	2.20	1.90	1.80	1.75	1.80	2.00	1.95
29	1.80	5.80	5.95	4.05	3.40	2.20	1.90	1.75	1.75	1.80	1.95	2.05
30	1.80	.....	5.50	3.95	3.35	2.20	1.90	1.75	1.75	1.90	2.00	4.20
31	1.80	.....	4.45	.....	3.30	.....	1.90	1.75	.....	1.85	.....	3.90

WEST VALLEY CREEK NEAR LIKELY, CAL.

This station was established January 7, 1904, by H. E. Green and J. S. Evans. It is located 7 miles east of Likely, Cal., at the outlet of West Valley. The gage is a 2 by 6 inch vertical plank nailed to a juniper tree on the right bank of the creek. Discharge measurements are made from cable and car, or by wading at low-water stage. The initial point for soundings is a juniper stump on left bank, which is

used for tying post for the car. The channel is straight for 200 feet above and 100 feet below station. The banks are high and not subject to overflow. The bed of the stream is rocky and not subject to change. The current is swift. The bench mark is on a large bowlder 30 feet from the creek on left bank and is marked with paint. It is 10.00 feet above the zero of the gage. As no one could be obtained to read the station gage, a gage was placed 2 miles above the station. The observer is Jasper L. Fountain. It is not deemed practical to make an estimated monthly discharge for the stream for 1904.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of West Valley Creek near Likely, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 7	J. S. Evans	3.18	21
February 2	do	3.30	20
February 16	do	4.95	200
February 25	do	3.75	74
March 18	do	3.70	74
April 2	do	3.50	51
May 24	do	4.30	138
June 6	do	3.90	70
June 14	S. G. Bennett	3.50	36
September 2	J. Y. Toler	2.90	10.3
September 17	do	3.04	15.8
September 24	do	3.15	14.8
September 30	do	3.20	16
October 12	do	3.35	20
October 19	J. Y. Toler and W. B. Clapp	3.30	29
October 29	J. Y. Toler	3.25	26
November 5	do	3.25	15.3
November 17	do	3.30	16.7
November 29	do	3.29	29
December 14	do	3.30	31
December 31	do	3.35	30

Mean daily gage height, in feet, of West Valley Creek near Likely, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3.20	4.20	3.70	5.25	4.10	2.70	3.00	3.00	3.10	3.20	3.30
2	.....	3.20	4.10	3.90	4.95	4.05	2.70	3.00	3.00	3.10	3.20	3.25
3	.....	3.20	3.70	3.90	4.55	4.00	2.70	3.00	2.50	3.10	3.20	3.25
4	.....	3.40	3.75	4.10	4.50	3.95	2.70	3.00	2.50	3.10	3.20	3.25
5	.....	3.20	3.85	4.00	4.40	3.90	2.70	3.10	2.50	3.10	3.20	3.25
6	.....	3.20	4.00	4.10	4.40	3.85	2.70	3.00	2.50	3.20	3.20	3.25
7	.....	3.20	4.95	4.40	4.50	3.80	2.90	3.00	2.50	3.20	3.20	3.25
8	.....	3.20	4.50	4.80	4.45	3.80	2.75	3.00	2.50	3.10	3.20	3.25
9	.....	3.20	4.65	5.40	4.40	3.70	2.70	3.00	2.50	3.20	3.20	3.30
10	.....	3.20	4.20	5.20	4.60	3.55	2.70	3.00	2.50	3.20	3.20	3.30
11	.....	3.20	4.20	4.80	4.80	3.50	2.70	3.00	2.50	3.35	3.20	3.30
12	.....	3.30	4.10	4.80	4.90	3.40	2.70	3.00	2.50	3.20	3.20	3.30
13	3.20	3.75	5.50	4.50	4.90	3.40	2.70	3.00	2.50	3.20	3.20	3.25
14	3.20	4.35	5.75	4.50	4.95	3.30	2.70	3.00	2.50	3.25	3.20	3.25
15	3.20	5.00	5.25	4.50	4.95	3.20	2.70	3.00	2.50	3.25	3.20	3.25
16	3.20	4.85	5.00	(4.40)	4.85	3.20	2.70	(3.00)	2.50	3.20	3.20	3.25
17	3.35	4.30	4.30	(4.30)	4.85	3.20	2.70	3.00	2.50	3.20	3.20	3.25
18	3.40	3.95	4.10	(4.10)	4.85	3.10	2.70	3.00	2.50	3.20	3.20	3.25
19	3.25	3.75	4.10	4.00	4.85	3.10	(2.70)	3.00	2.50	3.20	3.20	3.25
20	3.20	3.70	3.90	3.95	4.65	3.10	(2.60)	3.00	2.50	3.20	3.25	3.25
21	3.20	4.60	3.70	4.05	4.45	3.10	2.60	3.00	2.50	3.20	3.25	3.25
22	3.20	7.25	3.85	3.90	4.45	3.00	2.60	3.00	2.50	3.20	3.25	3.30
23	3.30	5.30	3.70	3.85	4.45	3.00	2.60	3.00	2.60	3.20	3.25	3.25
24	3.20	7.20	3.85	3.85	4.45	3.00	2.60	3.00	2.60	3.20	3.25	3.20
25	3.20	5.25	3.85	3.80	4.35	3.00	2.60	3.00	3.20	3.20	3.25	3.20
26	3.20	5.00	4.20	3.80	4.30	3.00	2.60	(3.00)	3.30	3.20	3.25	3.20
27	3.20	4.65	5.00	3.85	4.15	2.80	2.60	3.00	3.20	3.20	3.25	3.20
28	3.20	4.20	7.10	4.25	4.05	2.80	2.60	3.00	3.20	3.20	3.25	3.20
29	3.30	4.00	6.85	5.25	3.95	2.70	2.60	3.00	(3.20)	3.20	3.25	3.20
30	3.40	.....	6.00	5.95	3.95	2.70	3.00	3.00	(3.10)	3.25	3.30	3.35
31	3.40	.....	4.70	.....	4.00	.....	3.00	3.00	.....	3.30	.....	3.35

NOTE.—Gage heights in parenthesis are estimated.

PIT RIVER (SOUTH FORK) NEAR IVY, CAL.

This station was established January 11, 1904, by H. E. Green and J. S. Evans. It is located 3 miles west of Ivy post-office at outlet of Jess Valley.

The gage is a 2 by 6 inch vertical plank fastened to a tree on left bank 50 feet above station. It is only read at times discharge measurements are made, as it is impossible to get an observer on account of its isolated location.

Discharge measurements are made from cable and car. The initial point for soundings is foot of post used for fastening the car on the left bank of stream. The channel is straight for 200 feet above and 80 feet below the station. The current is sluggish at low-water stage. The right bank is low and subject to overflow in high water. The bed of the stream is composed of earth and is filled with vegetation at

low-water stage. The bench mark is on large bowlder 150 feet east of cabin on the right bank and below station. It is 12.00 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Pit River (South Fork) near Ivy, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 11	J. S. Evans	3.60	44
February 3	do	3.30	26
February 16	do	5.70	202
February 25	do	5.20	158
March 18	do	4.20	60
April 2	do	4.25	69
May 7	do	5.60	197
May 24	do	7.80	573
June 14	S. G. Bennett and J. S. Evans	5.80	222
September 3	J. Y. Toler	4.00	29
September 16	do	4.15	31
September 24	do	4.22	37
October 1	do	4.20	38
October 12	do	4.65	75
October 20	J. Y. Toler and W. B. Clapp	4.35	48
October 24	J. Y. Toler	4.24	33
November 6	do	4.23	43
November 18	do	4.23	39
November 30	do	4.20	32
December 15	do	4.20	33

Mean daily gage height, in feet, of Pit River (South Fork) near Ivy, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3.40	4.00	4.25	(4.50)	(7.30)	(5.00)	(4.50)	(4.10)	4.20	(4.25)	(4.20)
2	.....	3.30	4.05	4.25	(4.80)	(7.20)	(5.00)	(4.50)	(4.10)	(4.20)	(4.25)	(4.20)
3	.....	3.40	4.20	4.20	(5.00)	(7.00)	(4.95)	(4.50)	4.00	(4.20)	(4.25)	(4.20)
4	.....	3.40	4.30	4.30	(5.10)	(6.80)	(4.95)	(4.45)	(4.00)	(4.20)	(4.25)	(4.20)
5	.....	3.40	4.30	4.15	(5.40)	(6.60)	(4.95)	(4.45)	(4.00)	(4.20)	(4.25)	(4.20)
6	.....	3.35	4.20	4.10	(5.50)	(6.50)	(4.90)	(4.45)	(4.00)	(4.20)	4.25	(4.20)
7	.....	3.40	4.60	4.10	(5.60)	(6.40)	(4.90)	(4.40)	(4.00)	(4.20)	(4.25)	(4.20)
8	.....	3.40	5.00	4.25	(5.60)	(6.30)	(4.90)	(4.40)	(4.00)	(4.20)	(4.25)	(4.20)
9	.....	3.55	4.80	4.25	(5.70)	(6.20)	(4.85)	4.40	(4.00)	(4.20)	(4.25)	(4.20)
10	.....	3.35	4.70	(4.20)	(5.90)	(6.10)	(4.85)	4.35	(4.00)	(4.20)	(4.25)	(4.20)
11	3.60	3.40	4.50	(4.20)	(6.00)	(6.00)	(4.85)	(4.35)	(4.10)	(4.40)	(4.25)	(4.20)
12	3.60	3.30	4.40	(4.20)	(6.10)	(5.90)	(4.80)	(4.30)	(4.10)	4.65	(4.25)	(4.20)
13	3.40	3.60	4.30	(4.20)	(6.30)	(5.80)	(4.80)	4.30	(4.10)	(4.60)	(4.25)	(4.20)
14	3.40	3.40	4.15	(4.30)	(6.40)	5.80	(4.80)	(4.30)	(4.10)	(4.60)	(4.25)	(4.20)
15	3.40	3.90	4.25	(4.40)	(6.70)	(5.80)	(4.75)	(4.30)	(4.10)	(4.50)	(4.25)	(4.20)
16	3.50	5.50	4.20	(4.50)	(6.90)	(5.70)	(4.75)	(4.30)	4.15	(4.50)	(4.25)	(4.20)
17	3.45	5.05	4.20	(4.80)	(7.00)	(5.60)	(4.75)	4.30	(4.15)	(4.40)	(4.25)	(4.20)
18	3.40	4.30	4.20	(5.00)	(7.20)	(5.50)	(4.70)	(4.30)	(4.15)	(4.40)	(4.25)	(4.20)
19	3.40	3.90	4.20	(5.20)	(7.50)	(5.50)	(4.70)	(4.30)	(4.15)	(4.40)	(4.25)	(4.20)
20	3.40	3.90	4.40	(5.00)	(7.60)	(5.40)	(4.70)	4.25	(4.15)	4.35	(4.25)	(4.20)
21	3.40	3.70	4.45	(5.00)	(7.70)	(5.40)	(4.65)	(4.25)	(4.15)	(4.30)	(4.20)	(4.20)
22	3.40	5.90	4.30	(5.00)	(7.80)	(5.40)	(4.65)	(4.25)	(4.15)	(4.30)	(4.20)	(4.20)
23	3.40	5.80	4.10	(4.90)	(7.80)	(5.40)	(4.65)	(4.20)	(4.15)	(4.30)	(4.20)	(4.20)
24	3.40	5.40	4.00	(4.80)	7.80	(5.40)	(4.60)	(4.20)	4.20	4.25	(4.20)	(4.20)
25	3.30	5.25	4.20	(4.70)	(7.80)	(5.40)	(4.60)	(4.20)	(4.20)	(4.25)	(4.20)	(4.20)
26	3.25	5.45	4.20	(4.70)	(8.00)	(5.30)	(4.60)	(4.20)	(4.20)	(4.25)	(4.20)	(4.20)
27	3.20	4.80	4.30	(4.70)	(7.80)	(5.20)	(4.60)	(4.20)	(4.20)	(4.25)	(4.20)	(4.20)
28	3.20	4.20	5.30	(4.60)	(7.80)	(5.10)	(4.55)	(4.20)	(4.20)	(4.25)	(4.20)	(4.20)
29	3.20	4.00	5.30	(4.50)	(7.60)	(5.00)	(4.55)	(4.10)	(4.20)	(4.25)	(4.20)	(4.20)
30	3.25	.....	4.75	(4.40)	(7.50)	5.00	(4.55)	(4.10)	(4.20)	(4.25)	4.20	(4.20)
31	3.30	.....	4.45	.....	(7.50)	.....	(4.50)	(4.10)	.....	(4.25)	.....	(4.20)

NOTE.—Gage heights in parenthesis are estimated.

Rating table for Pit River (South Fork) near Ivy, Cal., from January 1 to June 30, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.20	25	4.30	74	5.40	168	6.50	316
3.30	28	4.40	80	5.50	180	6.60	332
3.40	31	4.50	86	5.60	192	6.70	350
3.50	34	4.60	94	5.70	204	6.80	368
3.60	37	4.70	102	5.80	216	6.90	386
3.70	41	4.80	110	5.90	228	7.00	406
3.80	46	4.90	118	6.00	242	7.20	446
3.90	51	5.00	128	6.10	256	7.40	488
4.00	56	5.10	138	6.20	270	7.60	532
4.10	62	5.20	148	6.30	284	7.80	576
4.20	68	5.30	158	6.40	300	8.00	625

Rating table for Pit River (South Fork) near Ivy, Cal., from July 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
4.00	30	4.30	45	4.60	70	4.90	100
4.10	34	4.40	52	4.70	80	5.00	110
4.20	39	4.50	60	4.80	90		

Estimated monthly discharge of Pit River (South Fork) near Ivy, Cal., for 1904.

[Drainage area, 91 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	37	25	[a] 30	1,845	0.33	0.38
February	228	28	76	4,372	.84	.91
March	158	56	82	5,042	.90	1.04
April	148	62	90	5,355	.99	1.10
May	625	86	372	22,873	4.09	4.72
June	466	128	234	13,924	2.57	2.87
July	110	60	85	5,226	.93	1.07
August	60	34	46	2,828	.51	.59
September	39	30	35	2,083	.38	.42
October	75	39	47	2,890	.52	.60
November	42	39	41	2,440	.45	.50
December	39	39	39	2,398	.43	.50
The year	625	25	98	71,276	1.08	14.70

[a] Mean for 21 days assumed as mean for entire month.

PIT RIVER NEAR CANBY, CAL.

This station was established December 26, 1903, by H. E. Green and J. S. Evans. It is located at the wagon bridge, 3½ miles southwest of Canby, Cal. The gage is a 1 by 6 inch vertical plank securely fastened to the first bridge pier from the left bank of the stream. It is read twice each day by Ernest M. Hess.

Discharge measurements are made from the bridge. The initial point for soundings is a nail in the railing post at the end of the bridge on the left bank. The channel is straight for 150 feet above and 200 feet below the station. The current is moderate at all stages. The banks are high and are not subject to overflow. The channel is rocky, but is not subject to much change. The bench mark is a

painted point on a large bowlder at the bend of the wagon road near the south end of the bridge. It is 24.90 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Pit River near Canby, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
December 27	J. S. Evans	3.60	169
1904.			
February 12	J. S. Evans	3.65	183
February 18	do	6.25	1,669
February 22	do	7.15	2,435
March 3	do	7.30	2,630
March 5	do	9.05	4,383
March 29	do	10.10	6,204
May 2	do	9.70	5,236
May 16	do	5.70	1,540
June 2	do	5.20	1,204
June 12	do	4.60	728
September 6	J. Y. Toler	2.70	9
September 19	do	2.75	16
September 22	do	2.75	19
September 26	do	2.82	20
October 3	do	3.00	41
October 7	do	3.18	48
October 13	do	3.28	76
October 21	do	3.50	128
November 4	do	3.45	110
November 9	do	3.50	117
November 22	do	3.50	127
December 6	do	3.50	106
December 10	do	3.35	82
December 20	do	3.68	213
December 29	do	3.50	131

Mean daily gage height, in feet, of Pit River near Canby, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.70	3.45	6.70	8.55	8.10	5.25	3.65	3.30	2.65	3.00	3.50	3.55
2	3.60	3.45	7.30	7.55	9.85	5.20	3.60	3.30	2.65	3.35	3.50	3.55
3	3.50	3.45	7.55	6.90	9.85	5.15	3.60	3.30	2.60	3.10	3.50	3.55
4	3.55	3.50	9.05	6.75	9.30	5.05	3.60	3.30	2.60	3.10	3.50	3.50
5	3.50	3.50	9.35	6.50	8.55	5.00	3.60	3.30	2.60	3.10	3.50	3.45
6	3.40	3.50	8.45	6.30	7.45	4.90	3.60	3.30	2.60	3.10	3.50	3.50
7	3.60	3.50	9.85	5.95	7.00	4.80	3.60	3.30	2.60	3.10	3.50	3.50
8	3.50	3.50	14.00	5.90	6.60	4.75	3.60	3.30	2.65	3.15	3.50	3.50
9	3.50	3.45	12.70	5.80	6.35	4.70	3.60	3.30	2.65	3.15	3.50	3.50
10	3.50	3.45	10.50	5.65	6.05	4.70	3.60	3.30	2.65	3.15	3.50	3.50
11	3.50	3.45	8.95	5.55	5.85	4.65	3.60	3.20	2.65	3.20	3.50	3.50
12	3.50	3.50	8.15	5.50	5.80	4.60	3.50	3.20	2.65	3.25	3.50	3.50
13	3.60	3.60	7.55	5.40	5.70	4.50	3.50	3.20	2.70	3.30	3.50	3.50
14	3.60	3.65	7.00	5.60	5.70	4.50	3.50	3.10	2.70	3.30	3.50	3.55
15	3.50	5.00	7.00	6.00	5.70	4.40	3.50	3.10	2.70	3.40	3.50	3.60
16	3.70	10.70	7.00	6.00	5.80	4.30	3.50	3.10	2.75	3.40	3.50	3.75
17	3.60	7.15	7.00	6.00	5.80	4.20	3.50	3.00	2.80	3.40	3.50	3.75
18	3.50	6.45	7.40	6.00	5.80	4.10	3.50	2.90	2.80	3.40	3.50	3.80
19	3.40	6.55	8.65	5.80	5.80	4.00	3.50	2.90	2.80	3.45	3.50	3.80
20	3.40	6.40	9.70	5.80	5.80	3.95	3.50	2.80	2.80	3.45	3.50	3.75
21	3.50	6.20	8.50	5.80	5.90	3.95	3.50	2.80	2.80	3.45	3.50	3.65
22	3.50	7.50	8.35	5.75	5.90	3.90	3.50	2.80	2.80	3.50	3.50	3.50
23	3.60	10.70	6.80	5.60	5.90	3.90	3.45	2.80	2.80	3.50	3.50	3.45
24	3.45	11.00	6.45	5.50	5.75	3.90	3.45	2.75	2.80	3.50	3.50	3.40
25	3.45	10.10	6.00	5.40	5.60	3.90	3.45	2.75	2.80	3.50	3.50	3.50
26	3.45	10.50	6.15	5.30	5.50	3.80	3.45	2.70	2.85	3.50	3.50	3.30
27	3.45	9.30	6.25	5.40	5.50	3.80	3.40	2.70	2.85	3.50	3.50	3.30
28	3.45	7.70	7.20	5.50	5.40	3.75	3.40	2.75	2.90	3.50	3.50	3.35
29	3.45	7.25	10.00	5.70	5.40	3.70	3.35	2.75	2.95	3.50	3.55	3.60
30	3.45	.....	9.80	6.70	5.35	3.70	3.35	2.70	3.00	3.50	3.55	4.60
31	3.45	.....	9.35	.....	5.30	.....	3.30	2.70	.....	3.50	.....	4.70

Rating table for Pit River near Canby, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.60	8	4.00	360	5.40	1,260	7.60	2,900
2.70	12	4.10	415	5.50	1,330	7.80	3,080
2.80	18	4.20	475	5.60	1,400	8.00	3,260
2.90	25	4.30	535	5.70	1,470	8.50	3,720
3.00	34	4.40	600	5.80	1,540	9.00	4,280
3.10	45	4.50	665	5.90	1,610	9.50	4,990
3.20	59	4.60	730	6.00	1,680	10.00	5,910
3.30	76	4.70	795	6.20	1,820	10.50	6,900
3.40	100	4.80	860	6.40	1,960	11.00	8,000
3.50	130	4.90	925	6.60	2,100	11.50	9,300
3.60	165	5.00	990	6.80	2,260	12.00	10,700
3.70	205	5.10	1,055	7.00	2,420	12.50	12,200
3.80	255	5.20	1,120	7.20	2,580	13.00	13,700
3.90	305	5.30	1,190	7.40	2,740	14.00	17,000

Estimated monthly discharge of Pit River near Canby, Cal., for 1904.

[Drainage area, 1,500 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	205	100	135	8,301	0.09	0.10
February	7,340	115	2,137	122,922	1.42	1.53
March	17,000	1,680	4,211	258,924	2.81	3.24
April	3,770	1,190	1,675	99,669	1.12	1.25
May	5,625	1,190	2,082	128,017	1.39	1.60
June	1,155	205	594	35,345	.40	.45
July	185	76	135	8,301	.09	.10
August	76	12	43	2,644	.03	.03
September	34	8	15	893	.01	.01
October	130	34	91	5,595	.06	.07
November	148	130	131	7,795	.09	.10
December	795	76	188	11,560	.13	.15
The year	17,000	8	953	689,966	.64	8.63

ASH CREEK AT ADIN, CAL.

This station was established March 13, 1904, by J. S. Evans and William Busch. It was originally located one-fourth of a mile above the town of Adin. During the summer the closing of waste gates in the dam at Adin interfered with the discharge at this point to such an extent that on August 15, 1904, the station was reestablished at a point 100 feet below the wagon bridge in the town of Adin, Cal., which is about 500 feet below the dam.

The gage is a 2 by 6 inch vertical plank fastened to a tree on left bank of the stream. The gage is read once each day by H. Williams. Discharge measurements are made from a suspension footbridge constructed with one-half-inch cables. The channel is straight for 200 feet above and 200 feet below the station. The left bank is high, but the right bank is subject to overflow from the side channel which, in flood, diverts water from above the station. The bed of the stream is gravelly and not subject to change.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Ash Creek at Adin, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
March 13	J. S. Evans	4.50	471
April 5	do	4.70	540
April 15	do	5.80	714
May 3	do	6.10	1,117
May 17	do	4.10	447
June 2	do	2.10	140
June 12	S. G. Bennett and J. S. Evans	1.10	54
August 30	J. Y. Toler	1.80	26
September 13	do	1.80	30
September 20	do	2.01	36
September 27	do	1.98	45
October 8	do	1.85	38
October 14	do	1.80	37
October 22	J. Y. Toler and W. B. Clapp	1.75	29
November 2	J. Y. Toler	1.77	33
November 10	do	1.75	33
November 24	do	1.78	42
December 7	do	1.75	36
December 21	do	1.83	41
December 28	do	1.85	42

Mean daily gage height, in feet, of Ash Creek at Adin, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1				4.40	5.80	3.50			1.80	1.80	1.80	1.80
2				4.50	6.00	2.00			1.80	1.80	1.80	1.80
3				4.60	6.10	(a)			1.80	1.80	1.80	1.80
4				4.90	6.20				1.80	1.80	1.90	1.80
5				4.90	6.00				1.80	1.80	1.90	1.80
6				4.90	5.00				1.80	1.80	1.80	1.80
7				4.70	5.10				1.80	1.80	1.80	1.80
8				4.60	5.00				1.80	1.80	1.80	1.80
9				4.50	4.30				1.80	1.80	1.80	1.80
10				4.60	4.10				1.80	1.80	1.80	1.90
11				4.90	4.20				1.80	1.90	1.80	1.90
12				5.20	4.20	1.10			1.80	2.00	1.80	1.90
13			4.50	5.30	4.00				1.80	1.80	1.80	1.90
14			4.60	4.80	4.00			1.70	1.80	1.80	1.90	1.90
15			5.65	5.80	4.10			1.70	1.80	1.80	1.90	1.90
16			5.35	5.20	4.00			1.70	1.80	1.80	1.90	1.90
17			5.75	5.20	4.20			1.80	1.80	1.80	1.80	1.90
18			5.70	4.80	4.20			1.80	1.80	1.80	1.80	1.80
19			8.30	4.40	4.10			1.80	1.90	1.80	1.80	1.80
20			7.70	4.50	4.10			1.80	2.00	1.80	1.80	1.80
21			5.85	4.40	4.00			1.80	1.90	1.80	1.80	1.80
22			5.05	4.30	4.00			1.80	1.90	1.75	1.80	1.80
23			4.85	4.20	4.00			1.80	1.90	1.80	1.80	1.80
24			4.50	4.00	4.00			1.80	1.90	1.80	1.80	1.80
25			4.40	4.00	4.00			1.80	1.95	1.80	1.80	1.80
26			4.50	4.10	4.00			1.80	2.00	1.80	1.80	1.80
27			4.90	4.30	4.00			1.80	2.00	1.80	1.80	1.80
28			6.00	4.60	3.90			1.80	1.80	1.80	1.80	1.80
29			6.85	4.20	3.70			1.80	1.80	1.80	1.80	1.90
30			5.60	5.70	3.50			1.80	1.80	1.90	1.80	5.60
31			4.70		3.60			1.80		1.80		5.40

[a] Dam put in creek at Adin mill one-fourth mile below station. Gage readings increased. Daily discharge interpolated between meter measurements from June 3 to August 13, inclusive.

Rating table for Ash Creek at Adin, Cal., from March 13 to June 2, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.00	47	2.40	182	3.80	380	5.40	688
1.10	54	2.50	195	3.90	398	5.60	735
1.20	62	2.60	208	4.00	416	5.80	785
1.30	70	2.70	221	4.10	434	6.00	835
1.40	79	2.80	234	4.20	452	6.20	885
1.50	88	2.90	247	4.30	470	6.40	935
1.60	98	3.00	260	4.40	488	6.60	985
1.70	108	3.10	275	4.50	506	6.80	1,035
1.80	118	3.20	290	4.60	524	7.00	1,085
1.90	128	3.30	305	4.70	542	7.20	1,140
2.00	138	3.40	320	4.80	560	7.40	1,200
2.10	149	3.50	335	4.90	580	7.60	1,260
2.20	160	3.60	350	5.00	600	7.80	1,320
2.30	171	3.70	365	5.20	644	8.00	1,380

Rating table for Ash Creek at Adin, Cal., from August 14 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*
1.70	28	1.90	36
1.75	29	1.95	39
1.80	31	2.00	42
1.85	33		

Estimated monthly discharge of Ash Creek at Adin, Cal., for 1904.

[Drainage area, 260 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March	1,470	488	[a] 735	45,193	2.77	3.19
April	785	416	550	32,727	2.08	2.32
May	885	335	505	31,051	1.91	2.20
June	335	50	76	4,522	.29	.32
July	45	35	40	2,460	.15	.17
August	31	28	30	1,845	.11	.13
September	42	31	33	1,964	.12	.13
October	42	29	32	1,968	.12	.14
November	36	31	32	1,904	.12	.13
December	400	31	55	3,382	.21	.24
The period				127,016		

[a] Mean for 19 days taken as mean for entire month.

PIT RIVER NEAR BIEBER, CAL.

This station was established January 22, 1904, by J. S. Evans and William Busch. It is located 12 miles below Bieber, Cal., near Muck Valley. The gage is a heavy wooden rod fastened to a large bowlder on the right bank of the stream. It is read once each day by F. H. Holabird. Discharge measurements are made from cable and car. The initial point for soundings is foot of platform at end of cable on right bank of stream. The channel is straight for 200 feet above and 300 feet below the station. The current is very sluggish at low-water stage. The banks are high and not subject to overflow. The channel is very rocky and rough, but not subject to change. The bench mark is on a large bowlder on right bank 50 feet east of pine tree to which cable is fastened. It is 12.00 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Pit River near Bieber, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 22	J. S. Evans	3.20	221
February 20	do	7.52	4,850
March 10	do	11.75	15,164
April 13	do	7.10	4,043
May 4	do	9.15	7,833
May 18	do	5.30	1,935
June 3	do	4.50	1,139
June 11	S. G. Bennett and J. S. Evans	4.00	712
August 29	J. Y. Toler	1.40	37
September 11	do	1.15	21
September 21	do	1.12	11
September 28	do	1.93	27
October 15	do	2.60	90
October 22	J. Y. Toler and S. G. Bennett	2.90	118
November 3	J. Y. Toler	3.00	142
November 11	do	2.95	139
November 25	do	3.05	163
December 8	do	2.71	73
December 27	do	3.45	280

Mean daily gage height, in feet, of Pit River near Bieber, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3.20	9.80	8.10	8.30	5.00	2.90	2.30	1.20	1.75	3.05	3.30
2	.....	3.10	9.40	7.90	9.35	4.70	2.90	2.30	1.20	1.75	3.20	3.25
3	.....	3.20	8.30	7.80	9.30	4.50	2.90	2.30	1.20	1.75	3.00	3.20
4	.....	3.30	8.30	7.40	9.20	4.50	2.90	2.20	1.20	1.80	3.00	3.10
5	.....	3.30	7.80	7.20	8.80	4.40	2.80	2.20	1.20	1.80	2.95	2.90
6	.....	3.40	9.20	7.20	8.20	4.40	2.80	2.20	1.20	2.50	2.95	2.80
7	.....	3.30	9.60	7.20	7.80	4.20	2.80	2.20	1.20	2.50	2.90	2.70
8	.....	3.40	12.00	7.20	7.30	4.20	2.70	2.20	1.15	2.80	2.95	2.80
9	.....	3.40	12.70	7.20	6.40	4.10	2.70	2.20	1.15	2.80	3.00	2.80
10	.....	3.30	11.70	7.20	6.40	4.00	2.70	2.20	1.15	2.80	2.95	3.15
11	.....	3.40	12.00	7.20	6.10	4.00	2.50	2.20	1.15	2.50	2.95	3.20
12	.....	3.40	10.80	7.10	5.90	4.00	2.50	2.10	1.15	2.50	2.95	3.30
13	.....	3.60	9.80	7.10	5.90	4.00	2.50	2.10	1.10	2.50	2.95	3.40
14	.....	3.80	9.20	7.10	5.80	3.80	2.50	2.10	1.10	2.60	3.00	3.30
15	.....	4.10	8.60	7.00	5.80	3.80	2.50	2.00	1.10	2.60	3.00	3.30
16	.....	6.60	7.50	6.80	5.80	3.40	2.40	1.80	1.10	2.60	3.00	3.30
17	.....	9.45	7.20	6.40	5.80	3.30	2.40	1.70	1.15	2.70	3.00	3.35
18	.....	8.10	7.50	6.40	5.80	3.30	2.40	1.70	1.15	2.70	3.20	3.35
19	.....	8.10	8.20	6.50	5.80	3.20	2.40	1.50	1.20	2.75	3.20	3.40
20	.....	7.40	8.60	6.80	5.70	3.20	2.70	1.40	1.20	2.80	3.10	3.40
21	.....	7.60	8.10	6.90	5.70	3.10	2.70	1.00	1.20	2.80	3.10	3.45
22	3.20	7.80	7.80	6.40	5.60	3.00	2.60	1.20	1.20	2.90	3.00	3.50
23	3.20	9.80	7.20	6.40	5.50	2.80	2.50	1.20	1.30	3.00	3.00	3.50
24	3.30	11.30	6.80	6.20	5.50	2.80	2.50	1.30	1.50	3.10	3.00	3.60
25	3.50	10.80	6.20	6.50	5.40	2.70	2.40	1.40	1.40	3.05	3.00	3.05
26	3.50	10.10	6.10	6.40	5.40	2.90	2.40	1.40	1.60	3.05	3.05	3.50
27	3.40	9.80	7.00	7.80	5.30	2.90	2.40	1.40	1.80	3.00	3.20	3.50
28	3.30	9.30	8.20	8.10	5.20	2.80	2.30	1.40	1.95	3.00	3.25	3.45
29	3.30	9.10	8.50	8.50	5.20	2.80	2.30	1.30	1.75	2.90	3.25	3.05
30	3.20	.....	8.70	8.50	5.10	2.80	2.30	1.20	1.75	3.20	3.30	3.80
31	3.20	.....	8.40	.....	5.00	.....	2.30	1.20	.....	3.10	.....	4.80

Rating table for Pit River near Bieber, Cal., from January 22 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.00	10	2.60	85	4.20	870	6.40	3,210
1.10	12	2.70	96	4.30	950	6.60	3,480
1.20	14	2.80	108	4.40	1,040	6.80	3,760
1.30	16	2.90	120	4.50	1,130	7.00	4,050
1.40	18	3.00	145	4.60	1,220	7.50	4,800
1.50	20	3.10	180	4.70	1,310	8.00	5,600
1.60	23	3.20	220	4.80	1,400	8.50	6,500
1.70	26	3.30	270	4.90	1,500	9.00	7,540
1.80	30	3.40	320	5.00	1,600	9.50	8,680
1.90	35	3.50	375	5.20	1,800	10.00	9,940
2.00	40	3.60	435	5.40	2,010	10.50	11,320
2.10	45	3.70	500	5.60	2,230	11.00	12,800
2.20	50	3.80	565	5.80	2,460	11.50	14,380
2.30	57	3.90	635	6.00	2,700	12.00	16,020
2.40	65	4.00	710	6.20	2,950	12.50	17,660

Estimated monthly discharge of Pit River near Bieber, Cal., for 1904.

[Drainage area, 2,948 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January[a]	375	220	238	14,634	0.08	0.09
February	13,740	180	3,949	227,149	1.34	1.45
March	18,320	2,820	7,590	466,691	2.57	2.96
April	6,500	2,950	4,207	250,334	1.43	1.60
May	8,320	1,600	3,439	211,456	1.17	1.35
June	1,600	96	542	32,251	.18	.20
July	120	57	83	5,103	.03	.03
August	57	10	33	2,029	.01	.01
September	38	12	16	952	.01	.01
October	220	28	103	6,333	.03	.03
November	270	120	165	9,818	.06	.07
December	1,400	96	304	18,692	.10	.12
The year	18,320	10	1,722	1,245,442	.58	7.92

[a] January 1 to 21, inclusive, discharge estimated at 220 second-feet.

FEATHER RIVER AT OROVILLE, CAL.

At Oroville, where Feather River breaks from the foothills on the western slope of the Sierra Nevada into Sacramento Valley, it has a drainage area of 3,350 square miles. This station was established January 1, 1902, by S. G. Bennett. It is located at the northeast edge of the town of Oroville, Cal. Observations of the daily river height were begun January 1, 1902, using the rod of the United States Weather Bureau, which has been in place for a number of years. This is a 2-inch vertical iron pipe. Readings on this rod have been taken and reported by the United States Weather Bureau during floods when there was danger of overflow on the lower Feather and Sacramento rivers. To avoid negative readings the height as read on the gage has been increased by 2 feet. On August 11, 1904, a new set of gage rods of 2 by 8 inch timber, painted white and graduated to feet and tenths, were set to read 2 feet more than the old gage. Three of the sections are bolted to a rock, and a fourth is nailed to one of the bridge piers. The gage is read twice each day by D. G. Page. Discharge measurements are made by means of a cable and boat, located 500 feet above the gage. Flood measurements are made by means of floats. The channel is straight for 300 feet above and 100 feet below the station. It has a width of about 200 feet at ordinary stages and of about 700 feet at

flood stages. The bed of the stream is composed mainly of rock and is rough and permanent. The current is swift at ordinary stages. A standard United States Geological Survey bench mark has been sulphured in the rock at an elevation of 15.00 feet above the zero of the gage. The minimum midsummer discharge, as far as known, was in 1900, when the stream was flowing 1,123 second-feet.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Feather River at Oroville, Cal., for 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 20	W. B. Newhall	3.42	3,403
February 19	S. G. Bennett	10.70	18,715
March 31	E. C. Murphy, S. G. Bennett, and W. B. Clapp	13.40	34,000
May 30	Wm. Watson and John Tarish	9.20	12,793
June 8	C. W. McConaughy	7.60	9,319
June 10	Wm. Watson	7.20	9,186
June 18	C. W. McConaughy and John Tarish	5.70	6,368
June 23	C. W. McConaughy and Geo. J. Carr	4.90	5,269
June 30	C. W. McConaughy	4.00	4,129
July 15	do	2.95	2,862
August 12	O. W. Peterson	1.90	1,941
September 25	do	4.65	4,679
November 1	do	2.75	2,519

Mean daily gage height, in feet, of Feather River at Oroville, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.30	3.00	11.65	12.35	9.35	8.80	3.95	(2.20)	1.80	2.15	2.70	3.80
2	4.60	3.10	11.95	11.95	9.25	8.65	3.85	(2.20)	1.80	2.10	3.15	3.50
3	4.00	3.05	12.15	12.00	9.25	8.65	3.80	(2.20)	1.75	2.05	2.95	3.40
4	3.75	3.10	13.05	11.90	9.50	8.55	3.85	(2.15)	1.70	2.00	2.80	3.20
5	3.30	3.85	12.55	11.65	9.90	8.25	3.75	(2.15)	1.70	1.90	2.70	2.90
6	3.20	3.65	12.00	11.80	9.95	8.10	3.65	(2.10)	1.70	1.90	2.70	2.65
7	3.10	3.45	12.05	11.75	10.25	7.90	3.60	2.10	1.60	2.05	2.60	2.60
8	3.00	3.40	15.35	11.55	10.45	7.65	3.45	2.05	1.60	2.30	2.50	2.50
9	3.00	3.30	14.70	11.75	10.55	7.40	3.35	2.00	1.50	4.30	2.40	2.40
10	3.10	3.20	15.65	11.90	10.75	7.05	3.30	2.10	1.50	7.80	2.30	3.35
11	3.45	3.25	14.30	12.45	11.25	6.90	3.20	1.95	1.50	12.25	2.55	3.35
12	3.45	9.00	12.35	12.75	11.55	6.75	3.15	1.90	1.50	7.00	2.80	3.30
13	3.30	7.15	11.95	13.20	11.80	6.55	3.05	2.00	1.50	5.30	2.70	3.10
14	3.25	5.05	11.85	14.30	11.65	6.40	3.00	2.00	1.40	4.40	2.60	3.05
15	8.10	11.65	12.20	14.20	11.65	6.25	3.10	2.00	1.45	4.40	2.80	2.95
16	3.20	20.35	11.75	13.30	11.30	6.15	3.00	1.90	1.40	4.50	3.40	2.80
17	3.45	16.75	15.80	12.70	11.20	5.95	3.00	1.90	1.40	4.20	2.95	2.70
18	3.75	11.85	20.45	11.90	11.05	5.75	2.95	1.80	1.35	3.95	2.90	2.55

Mean daily gage height, in feet, of Feather River at Oroville, Cal., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
19	3.80	10.45	19.75	12.50	10.40	5.50	2.80	1.85	1.40	3.90	2.90	2.55
20	3.45	9.55	19.15	11.95	10.25	5.35	2.75	1.80	1.50	4.05	2.70	2.70
21	3.30	9.65	16.70	11.30	10.00	5.25	2.70	1.80	1.60	3.45	2.60	2.80
22	3.45	17.80	14.70	10.90	10.75	5.15	2.65	1.80	2.00	2.80	2.70	3.05
23	3.45	16.40	13.55	10.40	10.85	4.95	2.60	1.80	4.20	2.70	2.60	3.85
24	3.35	21.50	12.80	10.30	10.60	4.75	[a](2.55)	1.80	4.80	2.70	2.50	4.70
25	3.25	18.70	12.00	10.15	10.55	4.55	(2.50)	1.90	4.70	2.60	2.40	4.50
26	3.15	17.15	11.65	10.05	10.70	4.45	(2.45)	1.90	4.05	2.50	2.40	4.10
27	3.10	16.05	11.50	9.95	9.65	4.25	(2.40)	1.95	3.80	2.50	2.70	3.90
28	3.00	13.90	13.75	9.95	9.50	4.05	(2.35)	1.90	2.80	2.25	3.10	3.60
29	3.00	12.55	16.70	9.70	9.05	4.00	(2.30)	1.80	2.55	2.25	2.20	3.25
30	2.90	.....	15.10	9.50	9.00	4.05	(2.25)	1.80	2.20	2.35	3.30	16.95
31	2.95	.....	13.40	.....	8.90	.....	(2.25)	1.80	.....	2.50	.....	12.80

[a] July 24 to August 6, inclusive, gage heights interpolated.

Rating table for Feather River at Oroville, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.30	1,570	3.20	3,090	5.20	5,630	10.50	18,100
1.40	1,630	3.30	3,210	5.40	5,910	11.00	20,100
1.50	1,690	3.40	3,330	5.60	6,190	11.50	22,500
1.60	1,750	3.50	3,450	5.80	6,470	12.00	25,100
1.70	1,810	3.60	3,570	6.00	6,750	12.50	28,100
1.80	1,870	3.70	3,690	6.20	7,050	13.00	31,100
1.90	1,930	3.80	3,810	6.40	7,350	13.50	34,600
2.00	1,990	3.90	3,930	6.60	7,660	14.00	38,100
2.10	2,050	4.00	4,050	6.80	7,980	14.50	41,850
2.20	2,120	4.10	4,180	7.00	8,300	15.00	45,600
2.30	2,190	4.20	4,310	7.20	8,640	15.50	49,600
2.40	2,260	4.30	4,440	7.40	9,000	16.00	53,600
2.50	2,330	4.40	4,570	7.60	9,400	16.50	57,850
2.60	2,410	4.50	4,700	7.80	9,800	17.00	62,100
2.70	2,500	4.60	4,830	8.00	10,260	17.50	66,600
2.80	2,610	4.70	4,960	8.50	11,520	18.00	71,100
2.90	2,730	4.80	5,090	9.00	12,900	19.00	80,500
3.00	2,850	4.90	5,220	9.50	14,400	20.00	90,500
3.10	2,970	5.00	5,350	10.00	16,150	21.00	100,500

Estimated monthly discharge of Feather River at Oroville, Cal., for 1904.

[Drainage area, 3,350 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	4,830	2,730	3,296	202,663	0.98	1.13
February	105,500	2,850	27,766	1,597,118	8.29	8.94
March	95,000	22,500	39,529	2,430,543	11.80	13.60
April	40,350	14,400	24,468	1,455,947	7.30	8.14
May	24,000	12,620	17,751	1,091,466	5.30	6.11
June	12,340	4,050	7,459	443,841	2.23	2.49
July	3,990	2,155	2,910	178,929	.87	1.00
August	2,120	1,870	1,964	120,762	.59	.68
September	5,090	1,600	2,252	134,003	.67	.75
October	26,600	1,930	4,137	254,374	1.23	1.42
November	3,330	2,120	2,556	152,093	.76	.85
December	61,675	2,260	5,874	361,178	1.75	2.02
The year	105,500	1,600	11,664	8,422,917	3.48	47.13

YUBA RIVER NEAR SMARTSVILLE, CAL.

This station was established June 2, 1903, by W. H. Stearns. It is located at what is called "The Narrows," 1 mile from Smartsville, Cal., 18 miles from the Southern Pacific Railway station at Wheatland, Cal., and 20 miles from Marysville, Cal. The gage is in two sections. The lower one is bolted to the rock wall on the left bank of the river and the upper one to the right bank. Both are painted white, and are graduated to feet and tenths. The observer, J. R. McKeel, reads the gage once each day. Discharge measurements are made from a car and cable. One auxiliary cable is stretched parallel to and 100 feet upstream from the main cable, and a second one is located 150 feet below the station cable for float measurements. The initial point for soundings is on the left bank at the eyebolt to which the cable is fastened. The channel is straight for 200 feet above and 300 feet below the station, and the current is swift at all stages. In the 150 feet above the cable the stream has a fall of 0.2 foot, and of 0.9 foot in the 200 feet below. Both banks are high and rocky and are not subject to overflow. The banks widen out considerably just below the station. The bed of the stream is composed of gravel and sand—tailings from hydraulic mining—and is constantly shifting. After the rains of 1904 it was found that the bed of the stream had been lowered for an average depth of 2 feet. The bench mark is a

cross in a projecting point of rock under the cable on the right bank of the river 350 feet from the initial point for soundings. It is 38.65 feet above the zero of the gage. Frequent discharge measurements are made on account of continual changes of the river bed. These changes, however, do not materially affect discharge measurements for the same gage height.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Yuba River near Smartsville, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 11	J. R. McKeel	6.3	2,594
January 18	do	5.9	2,020
January 29	do	5.5	1,701
February 8	do	6.0	2,162
February 25	A. C. Lootz	13.5	23,380
May 10	J. R. McKeel	10.3	10,801
May 23	do	11.2	15,910
May 28	do	9.3	8,862
June 13	do	8.3	6,711
June 23	do	7.2	4,343
July 11	do	5.1	1,468
July 17	O. W. Peterson	4.4	1,049
July 25	J. R. McKeel	4.1	849
August 6	do	3.8	669
August 13	O. W. Peterson	3.7	625
August 28	J. R. McKeel	3.5	495
September 11	do	3.4	444
September 23	O. W. Peterson	4.9	1,528
September 25	J. R. McKeel	5.45	2,256
October 27	do	4.7	968
November 13	do	4.5	787
November 28	do	5.15	1,522
December 26	do	5.2	1,537
December 27	do	5.0	1,391

Mean daily gage height, in feet, of Yuba River near Smartsville, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.10	5.50	10.00	9.60	9.30	8.50	5.90	3.90	3.50	3.80	4.90	5.50
2	5.80	5.50	9.60	9.50	9.20	8.30	5.70	3.80	(3.50)	3.80	5.30	5.10
3	5.70	5.50	10.00	9.50	8.80	8.70	5.80	3.80	3.50	3.70	5.00	5.00
4	6.30	5.90	10.90	9.50	9.10	8.50	5.70	3.80	(3.50)	3.70	4.80	4.90
5	5.70	6.10	10.90	9.40	9.30	8.30	5.60	3.80	3.40	3.70	4.80	4.80
6	5.70	5.90	10.20	9.60	9.80	8.30	5.40	3.80	(3.40)	3.70	4.70	4.80
7	5.60	5.90	10.60	9.70	9.80	8.20	5.30	3.80	3.40	3.90	4.70	4.70
8	5.60	6.00	12.50	10.10	10.20	8.20	5.20	3.70	3.40	4.40	4.70	4.70
9	5.50	5.80	11.10	10.30	10.20	8.10	5.10	3.70	3.40	6.00	4.70	4.80
10	5.60	5.70	13.10	10.50	10.20	8.10	5.00	3.70	(3.40)	6.50	4.60	5.00
11	6.30	5.70	11.10	10.80	10.20	8.20	4.90	3.70	3.40	11.50	4.60	4.80
12	5.90	10.50	10.50	10.80	10.30	8.20	4.90	3.70	(3.40)	7.50	4.50	4.80
13	5.70	8.50	9.80	11.20	10.40	8.10	4.80	3.70	3.40	6.10	4.50	5.00
14	5.70	7.50	10.70	11.40	11.20	8.00	4.70	(3.70)	(3.40)	5.70	4.50	4.90
15	5.60	9.50	10.60	11.40	10.20	7.70	4.60	3.70	3.40	5.90	5.40	4.80
16	5.70	20.00	10.50	11.10	10.20	7.40	(4.50)	(3.70)	(3.40)	5.70	5.00	4.80
17	5.70	17.00	14.80	10.30	9.80	7.30	4.40	3.70	3.40	5.40	4.70	4.70
18	5.90	(12.00)	15.50	9.90	9.70	7.20	4.30	(3.60)	(3.40)	5.20	4.70	4.70
19	6.10	(10.50)	15.10	11.30	9.50	7.20	4.30	3.60	3.40	5.10	4.80	4.70
20	5.80	(9.50)	13.30	9.90	9.30	7.00	4.30	3.60	(3.40)	5.00	4.70	4.70
21	5.70	(9.50)	10.80	9.30	10.10	6.70	4.20	(3.60)	3.40	4.90	4.70	4.60
22	5.60	20.30	10.30	9.10	11.20	6.80	4.20	3.60	3.40	4.90	4.70	4.60
23	5.80	14.30	9.10	8.90	11.10	7.00	4.20	(3.60)	5.00	4.90	4.60	4.70
24	5.70	20.30	9.30	9.20	11.00	6.50	4.10	3.60	5.50	4.80	4.60	6.50
25	5.70	13.50	9.10	8.90	11.10	6.40	4.10	(3.60)	5.50	(4.70)	4.60	5.50
26	5.60	12.40	8.70	9.70	9.30	6.40	4.10	3.60	4.90	4.70	4.50	5.20
27	5.60	11.20	9.00	9.20	9.40	6.40	4.00	(3.60)	4.50	4.70	4.80	5.00
28	5.50	10.60	14.80	9.30	9.20	6.20	4.00	3.50	4.10	4.70	5.20	4.90
29	5.50	10.30	13.30	8.90	9.50	6.10	4.00	(3.50)	4.00	4.70	4.90	4.90
30	5.50	.....	11.10	8.50	9.00	5.90	3.90	3.50	3.80	4.90	5.60	12.00
31	5.50	.....	10.20	.....	8.80	.....	3.90	(3.50)	.....	4.80	.....	11.40

NOTE.—Gage heights in parenthesis are estimated.

Rating table for Yuba River near Smartsville, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.40	445	5.10	1,370	6.80	3,290	10.00	10,780
3.50	495	5.20	1,450	6.90	3,450	10.50	12,340
3.60	545	5.30	1,530	7.00	3,620	11.00	14,080
3.70	595	5.40	1,610	7.20	3,970	11.50	15,940
3.80	645	5.50	1,700	7.40	4,350	12.00	17,880
3.90	695	5.60	1,790	7.60	4,750	12.50	19,880
4.00	745	5.70	1,880	7.80	5,170	13.00	21,960
4.10	795	5.80	1,980	8.00	5,600	13.50	24,080
4.20	845	5.90	2,080	8.20	6,040	14.00	26,280
4.30	895	6.00	2,190	8.40	6,500	15.00	31,000
4.40	945	6.10	2,310	8.60	6,980	16.00	36,000
4.50	1,000	6.20	2,430	8.80	7,480	17.00	41,000
4.60	1,055	6.30	2,550	9.00	8,000	18.00	46,000
4.70	1,110	6.40	2,680	9.20	8,530	19.00	52,000
4.80	1,170	6.50	2,820	9.40	9,070	20.00	58,000
4.90	1,230	6.60	2,970	9.60	9,630		
5.00	1,300	6.70	3,130	9.80	10,200		

Estimated monthly discharge of Yuba River near Smartsville, Cal., for 1904.

[Drainage area, 1,220 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	2,550	1,700	1,924	118,302	1.58	1.82
February	59,800	1,700	14,913	857,805	12.22	13.18
March	31,500	7,230	15,399	946,848	12.62	14.55
April	15,560	6,740	10,638	633,005	8.72	9.73
May	14,800	7,480	10,561	649,371	8.66	9.98
June	7,230	2,080	4,650	276,694	3.81	4.25
July	2,080	695	1,156	71,080	.95	1.10
August	695	495	580	35,663	.48	.55
September	1,700	445	637	37,904	.52	.58
October	15,940	595	1,855	114,060	1.52	1.75
November	1,790	1,000	1,180	70,215	.97	1.08
December	17,880	1,055	2,280	140,192	1.87	2.16
The year	59,800	445	5,481	3,951,139	4.49	60.73

BEAR RIVER ABOVE WHEATLAND, CAL.

This station was established by O. W. Peterson on October 8, 1904. It is located about 800 feet below McCourtney Crossing and 8 miles above Wheatland. The gage rods are 300 feet above the station, on the left bank of the river. The gage is made of 3 by 8 inch timber, painted white, and is graduated to feet and tenths. Two of the sections are bolted to the rock and the upper section is nailed to a tree. The gage is read once each day by George W. Dunlap. Discharge measurements are made from a car and cable. An auxiliary cable is located 150 feet downstream and parallel to the large one, so that float measurements can be made at very high water. The white oak tree to which the right end of the cable is fastened is the initial point for soundings. The channel is straight for 350 feet both above and below the station. At ordinary stages the velocity is moderate. Neither bank is subject to overflow. The bed of the stream is composed of gravel and is not subject to any material change. A standard United States Geological Survey bench mark is sulphured in a hole drilled in the rock between the two upper sections of the gage. Its elevation is 12.26 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Bear River above Wheatland, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
August 14	W. B. Clapp and O. W. Peterson	([a])	30
October 9	O. W. Peterson	4.90	771
October 31	do	3.70	176

[a] Measurement made before gage was established.

Mean daily gage height, in feet, of Bear River above Wheatland, Cal., for 1904.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1	.....	5.50	4.50	17	3.80	3.80	3.70
2	.....	4.80	4.00	18	3.80	3.60	3.60
3	.....	4.30	3.80	19	3.70	3.60	3.60
4	.....	3.70	3.80	20	3.60	3.50	3.60
5	.....	3.70	3.70	21	3.60	3.50	3.50
6	.....	3.60	3.70	22	3.60	3.50	3.50
7	.....	3.60	3.60	23	3.60	3.50	3.80
8	.....	3.60	3.60	24	3.60	3.50	5.50
9	4.80	3.60	3.80	25	3.50	3.40	4.40
10	4.10	3.60	3.90	26	3.50	3.40	4.00
11	9.00	3.60	3.80	27	3.50	3.70	3.90
12	4.70	3.60	3.70	28	3.40	3.60	3.80
13	4.00	3.60	3.90	29	3.40	3.50	3.80
14	3.90	3.60	3.80	30	3.60	3.50	5.80
15	5.10	4.40	3.80	31	3.70	.....	8.80
16	(4.40)	4.00	3.70				

AMERICAN RIVER NEAR FAIROAKS, CAL.

This station was established November 3, 1904, by O. W. Peterson. It is located at Fairoaks Bridge, near Fairoaks. The gage is made of 2 by 8 inch timber, painted white, and is graduated to feet and tenths. It is nailed to one of the piles at the upper side at the right end of the Fairoaks Bridge. The gage is read twice each day by J. P. Jones. Discharge measurements are made from the downstream side of the bridge.

The vertical face of the right abutment is 4 feet from the initial point for soundings. The channel is straight for 400 feet above and below the station. At ordinary stages the velocity is moderate. The right bank is not subject to overflow. At times of very high water the left bank is subject to overflow and a second channel is formed. The bed of the stream is composed of gravel, and is subject to slight changes at times of high water. At ordinary stages the river is about 210 feet in width and averages over 4 feet in depth. The bench mark is a nail driven in the guard rail over the upstream center pier, and is 31.00 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of American River near Fairoaks, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
October 29	O. W. Peterson	2.60	887
November 3	do	2.80	1,122

Mean daily gage height, in feet, of American River near Fairoaks, Cal., for 1904.

Day.	Nov.	Dec.	Day.	Nov.	Dec.	Day.	Nov.	Dec.
1	.....	3.05	12	(2.40)	2.65	23	2.55	2.70
2	.....	3.30	13	2.45	2.70	24	2.55	2.65
3	.....	3.10	14	2.60	2.55	25	2.65	2.70
4	2.75	2.65	15	2.65	2.50	26	2.60	2.55
5	2.70	2.70	16	2.75	2.55	27	2.60	2.50
6	2.70	2.55	17	2.70	2.70	28	2.70	2.40
7	2.60	2.55	18	2.50	2.60	29	2.70	2.60
8	2.50	2.60	19	2.65	2.40	30	3.05	3.70
9	2.50	2.55	20	2.60	2.65	31	.....	7.85
10	2.40	2.55	21	2.55	2.65			
11	(2.40)	2.60	22	2.50	2.90			

SACRAMENTO RIVER AT SACRAMENTO, CAL.

Gage height and turbidity records were taken at this station during 1904.

Mean daily gage height, in feet, of Sacramento River at Sacramento, Cal., for 1904.

[Observer, J. C. Pierson.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	13.1	25.4	24.0	20.8	20.5	15.5	10.3	9.0	9.7	11.1	11.9
2	.....	13.0	24.5	23.8	20.8	20.4	15.3	10.2	9.0	9.5	11.3	12.4
3	.....	13.0	24.3	23.6	20.9	21.2	15.0	10.0	8.9	9.5	11.6	12.5
4	.....	12.8	23.9	23.3	21.0	20.5	14.7	10.0	8.9	9.4	11.6	12.2
5	.....	13.2	23.6	23.0	21.2	20.5	14.4	9.9	8.9	9.3	11.5	11.9
6	.....	13.4	23.4	22.9	21.4	20.4	14.2	9.9	8.8	9.2	11.2	11.5
7	.....	13.7	23.2	22.5	22.0	20.3	13.9	10.0	8.8	9.1	11.0	11.2
8	.....	13.8	23.0	22.4	21.8	19.9	13.8	9.9	8.7	9.3	11.0	11.0
9	.....	13.9	23.0	22.2	21.6	19.9	13.5	9.7	8.7	10.5	10.9	10.9
10	14.1	13.7	23.0	22.2	21.7	19.9	13.3	9.6	8.7	11.2	10.8	10.8
11	14.2	13.5	22.9	22.2	21.8	19.0	13.2	9.5	8.6	13.5	10.7	10.8
12	14.3	14.8	23.6	22.0	21.8	19.5	13.0	9.5	8.6	17.8	10.6	11.2
13	14.4	19.9	23.7	22.2	22.0	19.3	12.9	9.3	8.5	16.2	10.6	11.1
14	14.2	19.4	23.7	22.2	21.1	19.2	12.6	9.6	8.5	15.1	10.5	11.3
15	13.9	18.8	24.0	22.3	21.8	19.0	12.4	10.0	8.4	13.9	10.4	11.8
16	13.6	22.4	23.8	22.1	21.8	19.1	12.3	10.0	8.4	13.3	10.6	11.9

Mean daily gage height, in feet, of Sacramento River at Sacramento, Cal., for 1904—Con.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
17	13.5	21.8	23.3	22.0	21.6	19.0	12.0	9.9	8.4	13.1	10.9	11.8
18	13.8	21.4	24.2	22.2	21.6	18.9	12.0	9.8	8.4	12.6	10.9	11.5
19	14.4	21.4	24.3	22.0	21.5	18.7	12.0	9.8	8.4	12.3	11.0	11.2
20	15.2	21.6	25.9	22.0	21.2	18.5	11.9	9.7	8.3	12.0	11.0	11.1
21	15.1	22.4	26.3	21.8	21.2	18.2	11.7	9.7	8.2	11.9	11.0	11.0
22	14.9	23.8	26.2	21.8	21.4	18.0	11.6	9.6	8.2	11.9	11.0	10.9
23	14.7	25.0	25.9	21.6	21.4	17.9	11.5	9.4	8.2	11.8	10.9	10.8
24	14.5	25.6	25.4	21.5	21.2	17.8	11.4	9.4	8.7	11.8	10.8	10.9
25	14.4	27.1	25.0	21.3	21.4	17.3	11.2	9.3	9.9	11.7	10.7	10.5
26	14.2	27.8	24.5	21.2	21.1	17.0	11.0	9.3	11.6	11.6	10.6	12.7
27	14.0	27.7	24.0	21.1	20.8	16.6	11.0	9.3	11.8	11.5	10.5	13.2
28	13.7	26.7	23.7	21.1	20.8	16.2	10.8	9.3	11.1	11.4	10.6	12.8
29	13.5	26.0	23.9	21.0	20.7	15.8	10.7	9.2	10.4	11.3	11.5	12.3
30	13.4	.....	24.4	20.8	20.7	15.7	10.6	9.1	10.0	11.1	12.0	12.0
31	13.3	.....	24.2	.....	20.6	.....	10.5	9.0	.....	11.0	.....	18.6

Daily turbidity record of Sacramento River at Sacramento, Cal., for 1904.

[Observer, J. C. Pierson.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	85	250	200	95	75	60	40	50	90	70	150
2	.....	100	250	150	90	85	65	45	45	80	100	150
3	.....	85	300	150	90	75	70	35	50	65	60	180
4	.....	110	300	120	80	90	65	40	55	85	75	140
5	.....	150	200	130	80	85	75	35	55	65	55	110
6	.....	400	250	130	95	75	75	30	60	75	60	80
7	.....	180	200	200	110	85	70	45	55	65	75	65
8	.....	180	150	200	100	80	70	40	50	65	70	65
9	.....	100	150	200	110	80	65	40	45	150	65	45
10	160	110	300	180	110	75	60	50	50	250	70	75
11	170	75	300	160	120	75	55	45	50	200	70	75
12	180	350	300	100	100	80	55	55	50	400	65	75
13	250	600	250	100	100	75	55	40	50	200	70	55
14	90	400	200	110	100	75	55	55	55	200	75	60
15	100	160	250	100	100	75	55	65	50	140	75	70
16	100	700	250	110	90	70	60	65	40	110	50	100
17	100	400	150	120	90	70	50	50	45	90	180	110
18	110	250	300	130	90	75	50	65	45	85	100	90
19	200	180	250	100	100	70	40	60	40	200	65	80
20	130	160	300	130	110	70	40	60	40	140	60	80
21	110	300	250	130	110	75	50	60	40	90	65	60
22	120	800	250	100	100	60	40	60	40	55	70	60
23	100	1,000	250	95	100	65	45	65	55	60	120	80
24	100	450	200	95	90	65	45	60	85	60	100	100
25	100	600	180	100	85	60	40	50	150	60	80	80
26	100	500	150	100	100	60	45	55	150	60	70	200
27	100	450	250	110	95	60	45	55	250	55	75	160
28	100	350	200	100	95	60	50	55	100	60	80	200
29	100	250	300	100	90	65	40	60	160	55	110	110
30	95	.....	250	90	85	65	40	60	140	60	110	200
31	90	.....	250	.....	85	.....	40	50	.....	60	.....	1,500

MOKELUMNE RIVER AT ELECTRA, CAL.

This station was established January 1, 1900, by Burr Bassell. It is located 3 miles above the wagon bridge, on the Mokelumne Hill and Jackson road. It is one-half mile below the Standard Electric Company's power house and the post-office at Electra, Cal. The gage is a large inclined timber bolted to a tree on the left bank. It is read twice each day by H. F. Vogt. Discharge measurements are made by means of a cable and car 200 feet below the gage. The initial point for soundings is the anchor sheave to which the cable is fastened on the right bank. The channel is straight for 300 feet above and for 900 feet below the station. The current is swift at all stages, but there are cross currents at extreme low water. Both banks are high and are not liable to overflow. The lower part of the right bank is composed of hard gravel. The upper part of the right bank and the entire left bank are composed of solid rock. The bed of the stream is composed of rock and gravel and is fairly permanent.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Mokelumne River at Electra, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 8	S. G. Bennett	4.25	176
February 24	W. B. Newhall	12.00	17,300
February 24	do	12.70	19,000
February 26	do	8.65	4,663
February 27	do	8.95	5,742
February 28	do	8.30	4,029
June 10	O. W. Peterson	8.15	4,460
July 19	do	4.75	500
August 16	W. B. Clapp and O. W. Peterson	4.15	96

Mean daily gage height, in feet, of Mokelumne River at Electra, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.35	3.90	7.00	7.70	7.05	7.90	6.25	4.25	4.25	4.25	4.50	4.60
2	4.30	3.90	7.10	7.55	7.00	8.00	6.00	4.20	4.30	4.55	4.55	4.50
3	4.45	4.00	7.45	7.20	7.05	8.75	5.95	4.35	4.30	4.45	4.50	4.45
4	4.55	3.90	7.35	7.00	7.45	8.60	5.70	4.30	4.15	4.35	4.40	4.40
5	4.20	4.90	8.00	7.30	7.95	8.70	5.50	4.40	4.20	4.30	4.20	4.25
6	4.10	4.85	6.80	7.25	7.95	8.80	5.60	4.55	4.15	4.25	4.15	4.25
7	4.15	5.00	7.25	7.50	8.70	8.85	5.90	4.20	4.05	5.40	4.10	4.35
8	4.20	4.45	8.85	7.40	8.70	7.80	5.70	4.30	4.15	5.65	4.15	4.30
9	4.10	4.40	7.30	7.90	9.10	7.90	5.50	4.25	4.15	5.55	4.10	4.45
10	4.20	4.45	8.85	8.05	9.50	7.95	5.60	4.35	4.15	5.65	4.25	4.40
11	4.20	4.35	7.80	8.50	9.70	7.90	5.25	4.30	4.20	8.85	4.20	4.35
12	4.20	6.55	7.25	8.30	9.90	7.95	5.10	4.35	4.15	6.75	4.20	4.25
13	4.15	6.25	7.05	9.00	9.90	8.00	5.10	3.95	4.05	6.05	4.20	4.15
14	4.15	4.55	6.90	9.20	9.40	8.05	4.95	3.95	4.20	5.70	4.20	4.20
15	4.15	4.45	7.05	9.35	9.40	7.90	4.85	3.95	4.10	5.30	4.20	4.30
16	4.20	8.45	6.95	8.00	9.15	7.75	4.75	4.10	4.25	5.15	4.10	4.35
17	4.15	6.75	7.55	7.60	9.15	7.60	4.50	3.95	4.25	5.10	4.30	4.35
18	4.20	5.95	8.85	7.80	9.20	7.55	4.35	4.00	4.20	4.95	4.15	4.25
19	4.10	5.70	9.95	8.60	8.30	7.20	4.50	4.10	4.20	4.80	4.35	4.25
20	4.70	5.50	10.50	7.80	8.20	8.30	4.60	4.00	4.05	4.50	4.20	4.35
21	4.50	5.90	9.10	7.40	8.75	7.50	4.65	4.05	4.15	4.35	4.25	4.35
22	4.45	6.50	8.25	7.55	9.50	7.20	5.00	4.15	4.15	4.25	4.25	4.35
23	4.35	9.80	8.20	7.05	9.60	7.00	4.60	4.10	4.35	4.55	4.30	4.40
24	4.30	9.55	7.95	6.90	9.50	6.85	4.50	4.10	4.55	5.05	4.30	4.50
25	4.25	11.45	7.55	7.30	9.40	6.50	4.60	4.15	4.70	4.75	4.40	4.70
26	4.20	9.45	7.35	7.75	7.85	6.50	4.45	4.05	5.20	4.95	4.40	4.45
27	4.25	9.80	7.35	7.15	7.85	6.45	4.40	4.15	4.60	4.75	4.50	4.55
28	4.20	8.00	8.35	7.00	8.25	6.20	4.40	4.10	4.25	4.60	4.85	4.60
29	4.25	7.60	9.90	6.95	8.40	6.30	4.20	4.05	4.10	4.60	4.45	4.55
30	4.20	.....	8.60	7.05	8.45	6.30	4.05	4.30	4.15	4.60	4.45	5.30
31	4.15	.....	7.95	.....	8.25	.....	4.30	4.15	.....	4.55	.....	6.35

Rating table for Mokelumne River at Electra, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
4.00	25	5.50	1,100	7.00	2,750	9.00	5,900
4.10	70	5.60	1,200	7.10	2,880	9.20	6,300
4.20	120	5.70	1,300	7.20	3,010	9.40	6,700
4.30	180	5.80	1,400	7.30	3,140	9.60	7,140
4.40	240	5.90	1,500	7.40	3,270	9.80	7,620
4.50	310	6.00	1,600	7.50	3,400	10.00	8,100
4.60	380	6.10	1,700	7.60	3,550	10.20	8,660
4.70	460	6.20	1,800	7.70	3,700	10.40	9,220
4.80	540	6.30	1,900	7.80	3,850	10.60	9,840
4.90	620	6.40	2,000	7.90	4,000	10.80	10,520
5.00	700	6.50	2,100	8.00	4,150	11.00	11,200
5.10	780	6.60	2,230	8.20	4,490	11.50	13,200
5.20	860	6.70	2,360	8.40	4,830	12.00	15,600
5.30	940	6.80	2,490	8.60	5,180	12.50	18,600
5.40	1,020	6.90	2,620	8.80	5,540	13.00	22,200

Estimated monthly discharge of Mokelumne River at Electra, Cal., for 1904.

[Drainage area, 537 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	460	95	157	9,654	0.29	0.33
February	13,000	5	2,491	143,284	4.64	5.00
March	9,500	2,490	4,170	256,403	7.77	8.96
April	6,600	2,620	3,780	224,926	7.04	7.85
May	7,860	2,750	5,411	332,709	10.08	11.62
June	5,450	1,800	3,607	214,631	6.72	7.50
July	1,850	42	722	44,394	1.34	1.54
August	345	15	111	6,825	.21	.24
September	860	42	165	9,818	.31	.35
October	5,630	150	827	50,850	1.54	1.78
November	580	70	189	11,246	.35	.39
December	1,950	95	315	19,369	.59	.68
The year	13,000	5	1,829	1,324,109	3.41	46.24

MOKELUMNE RIVER NEAR CLEMENTS, CAL.

This station was established by O. W. Peterson on October 28, 1904. It is located at the bridge 1 mile north of Clements. The gage is made of 3 by 8 inch timber, painted white and graduated to feet and tenths. One section is a sloping gage and is nailed to posts driven in the ground on the right bank. The other section is nailed to a pile near the sloping rod. The gage is read twice each day, except in times of low water, by Allen Gaskill, the observer. Discharge measurements are made from the downstream side of the bridge. The right end of the bridge is the initial point for soundings. The channel is straight for 150 feet above and 500 feet below the station. At ordinary stages the velocity is moderate. Neither bank is subject to overflow, but for gage heights above 15 feet the river spreads over a terrace on the left side for 200 feet. The bed of the stream is composed of gravel and silt and is subject to slight changes. Ordinarily the width of the river is about 100 feet. The head of a bolt driven in a pile to which the upper section of the gage is fastened is the bench mark. Its elevation is 9.60 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Mokelumne River near Clements, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
August 17	O. W. Peterson and W. B. Clapp	.....	109
October 27	O. W. Peterson	4.30	334
November 4	do	4.10	280

Mean daily gage height, in feet, of Mokelumne River near Clements, Cal., for 1904.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1	.....	4.40	4.15	17	.....	4.05	3.90
2	.....	4.25	4.75	18	.....	3.95	3.90
3	.....	4.50	4.15	19	.....	4.05	3.90
4	.....	4.20	4.05	20	.....	4.00	3.80
5	.....	4.10	3.95	21	.....	3.90	3.90
6	.....	4.10	4.00	22	.....	3.95	3.90
7	.....	4.15	3.90	23	.....	3.95	3.90
8	.....	4.20	3.80	24	.....	3.85	4.00
9	.....	3.95	4.00	25	.....	3.80	4.70
10	.....	3.95	4.10	26	.....	3.85	4.20
11	.....	3.85	3.90	27	.....	3.95	4.00
12	.....	3.90	3.85	28	4.30	3.95	4.10
13	.....	3.80	3.90	29	4.35	4.40	3.90
14	.....	3.85	3.85	30	4.25	4.20	4.10
15	.....	3.95	3.80	31	4.60	.....	6.65
16	.....	4.00	3.85				

STANISLAUS RIVER AT KNIGHTS FERRY, CAL.

This station was established May 19, 1903, by W. H. Stearns. The station is located 200 feet from the post-office at Knights Ferry. There is an island 800 feet above the gaging station and a dam on each channel at the head of the island. The Stanislaus Milling and Power Company's power house is on the right bank of the river below one of these dams and about 1,000 feet above the gaging station. Ordinary and low water stages are read on a 2-inch iron pipe driven into the bed of the stream. For high stages the gage is a 1 by 6 inch plank nailed to a 6 by 6 inch post on the right bank of the river. The graduations on both gages are to feet and tenths. The gage height is read twice each day by J. T. Cannon. Discharge measurements are made from a car suspended from a ¾-inch galvanized-iron cable. Above and parallel with the main cable is another smaller one, from which a stay line can be run to the meter to hold it, in flood measurements,

against the swift current. The initial point for soundings is the eye-bolt, to which the cable is fastened on the right bank. The channel is straight for 500 feet above and below the cable. At ordinary and high stages the stream has a fall of 0.47 foot in the 500 feet above the cable, and of 0.68 foot in the 500 feet below. Both banks are composed of cemented gravel and are high. The left bank is not subject to overflow. In extreme floods the right bank has been known to be overflowed, flooding the yards and houses next the river. The bed is of gravel and is subject to some change from the addition of material which is washed down from the island above. The bench mark is a spike driven into a 6 by 6 inch redwood post near the upper section of the gage. Its elevation is 12.00 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Stanislaus River at Knights Ferry, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 20	F. W. Huber	6.60	345
February 14	J. T. Cannon	8.00	1,528
February 16	do	13.00	14,314
February 28	do	11.45	8,687
March 1	do	10.00	4,017
March 15	do	9.50	2,983
March 21	do	12.00	9,330
March 27	S. G. Bennett and W. B. Clapp	10.45	4,327
April 17	J. T. Cannon	10.80	5,091
May 8	do	11.55	7,608
May 22	do	12.25	8,754
May 29	do	11.20	6,215
June 19	do	10.00	3,832
June 29	do	9.00	2,408
July 9	do	8.70	1,832
July 11	do	8.10	1,291
July 22	O. W. Peterson and J. T. Cannon	7.50	798
August 3	J. T. Cannon and John McGrath	6.90	382
August 24	O. W. Peterson	6.30	84
August 28	John McGrath	6.45	210
September 11	do	6.00	74
September 29	do	6.85	330
October 23	do	7.50	744
November 6	do	7.25	445
November 27	do	6.80	292

Mean daily gage height, in feet, of Stanislaus River at Knights Ferry, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.40	6.50	9.95	10.60	10.10	10.95	8.90	7.15	6.20	7.15	7.20	7.00
2	6.40	6.45	9.65	10.45	9.85	10.85	8.70	7.05	6.20	7.30	7.20	7.10
3	6.40	6.40	9.80	10.30	9.90	11.75	8.65	7.00	6.15	7.30	7.15	7.10
4	6.40	6.45	9.80	10.30	10.45	11.20	8.65	7.10	6.15	7.10	7.10	7.05
5	6.15	7.00	9.75	10.15	10.90	(11.25)	8.95	7.20	6.10	7.05	7.10	6.95
6	6.40	6.65	9.70	10.15	11.55	11.35	8.50	7.15	6.10	7.10	7.05	6.90
7	6.30	7.20	9.75	10.40	12.10	11.20	8.50	7.15	6.10	8.15	7.00	6.90
8	6.35	7.10	10.30	10.60	11.75	11.05	8.40	7.10	6.15	8.80	7.00	6.90
9	6.30	7.00	10.00	10.95	12.15	10.60	8.35	6.95	6.10	8.35	7.00	6.95
10	6.30	6.85	10.55	11.30	12.50	10.65	8.10	6.85	6.10	8.35	6.95	6.90
11	6.35	6.80	10.40	11.50	12.40	11.15	8.05	6.80	6.05	10.35	6.90	6.85
12	6.40	9.75	10.00	11.75	12.90	11.70	8.05	6.75	6.00	9.25	6.90	6.90
13	6.40	9.00	(9.70)	12.05	12.80	10.50	8.00	6.65	6.00	8.70	6.90	6.90
14	6.40	8.00	9.45	12.30	13.10	10.40	7.85	6.60	6.00	8.40	6.85	6.90
15	6.50	7.70	9.60	11.90	12.80	10.35	7.65	6.60	6.00	8.10	6.80	6.90
16	6.45	12.80	9.45	11.15	12.65	10.30	7.70	7.00	6.00	8.00	6.80	6.90
17	6.40	9.40	9.95	10.75	12.70	10.15	(7.70)	6.85	6.05	7.75	6.85	6.90
18	6.50	8.60	10.85	10.80	12.60	10.00	7.65	6.70	6.10	7.65	6.80	6.85
19	6.55	8.25	11.85	11.60	11.55	10.00	7.70	6.60	6.05	7.55	6.90	6.80
20	6.55	8.00	15.45	10.65	11.45	9.75	7.65	6.60	6.10	7.50	6.90	6.80
21	6.50	8.10	12.90	10.20	12.00	9.85	7.65	6.60	6.05	7.55	6.90	6.80
22	6.40	8.85	11.60	10.20	12.70	9.90	7.65	6.45	6.00	7.50	6.85	6.80
23	6.60	12.20	11.50	10.00	13.20	9.85	7.60	6.40	6.15	7.55	6.80	6.80
24	6.60	15.10	11.75	9.70	13.10	9.60	(7.50)	6.35	6.80	7.45	6.80	7.00
25	6.60	14.25	11.25	9.95	12.95	9.25	(7.45)	6.45	7.25	7.40	6.75	7.20
26	6.55	11.60	10.40	10.35	11.35	(8.75)	(7.40)	6.45	7.35	7.35	6.70	7.10
27	6.50	14.05	10.40	10.05	11.30	8.25	(7.35)	6.50	7.20	7.35	6.80	6.90
28	6.50	11.20	10.45	9.90	11.10	8.50	(7.30)	6.50	6.90	7.35	6.80	6.90
29	6.50	10.35	12.70	9.80	11.40	9.00	(7.25)	6.40	6.85	7.30	7.15	6.90
30	6.50	.....	11.50	10.05	11.25	8.85	(7.20)	6.30	7.05	7.30	7.05	6.90
31	6.50	.....	11.15	.....	11.15	.....	7.15	6.35	.....	7.20	.....	8.25

NOTE.—Gage heights in parenthesis are estimated.

Rating table for Stanislaus River at Knights Ferry, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
6.00	60	7.60	890	9.10	2,440	11.20	6,330
6.10	70	7.70	980	9.20	2,560	11.40	6,990
6.20	80	7.80	1,070	9.30	2,680	11.60	7,700
6.30	95	7.90	1,160	9.40	2,800	11.80	8,500
6.40	125	8.00	1,250	9.50	2,950	12.00	9,300
6.50	160	8.10	1,340	9.60	3,100	12.20	10,200
6.60	200	8.20	1,440	9.70	3,250	12.40	11,200
6.70	245	8.30	1,540	9.80	3,400	12.60	12,200
6.80	295	8.40	1,640	9.90	3,550	12.80	13,250
6.90	350	8.50	1,740	10.00	3,700	13.00	14,400
7.00	410	8.60	1,840	10.20	4,040	13.50	17,400
7.10	480	8.70	1,960	10.40	4,400	14.00	20,400
7.20	550	8.80	2,080	10.60	4,800	14.50	23,400
7.30	630	8.90	2,200	10.80	5,230	15.00	26,900
7.40	710	9.00	2,320	11.00	5,730	15.50	30,400
7.50	800						

Estimated monthly discharge of Stanislaus River at Knights Ferry, Cal., including Stanislaus Water Company's ditch and Schell ditch,[a] for 1904.

[Drainage area, 935 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	257	132	199	12,236	0.21	0.24
February	27,692	217	4,712	271,037	5.04	5.44
March	30,152	2,977	6,140	377,534	6.57	7.57
April	10,807	3,357	5,389	320,668	5.76	6.43
May	15,712	3,587	9,547	587,022	10.21	11.77
June	8,418	1,611	4,558	271,220	4.88	5.44
July	2,340	624	1,295	79,626	1.39	1.60
August	630	201	372	22,873	.40	.46
September	770	145	261	15,531	.28	.31
October	4,370	545	1,174	72,186	1.26	1.45
November	613	276	412	24,516	.44	.49
December	1,540	317	436	26,809	.47	.54
The year	30,152	132	2,875	2,081,258	3.08	41.74

[a] Mean daily flow of Schell ditch estimated at 7 second-feet.

STANISLAUS WATER COMPANY'S DITCH AT KNIGHTS FERRY, CAL.

This station was established June 11, 1904, by S. G. Bennett. Measurements are made below the point where Schell ditch takes out water. The station is located about a mile below the Stanislaus Milling and Power Company's power house and about 200 feet below the place where it passes under Schell ditch flume. The gage is painted white and is graduated to feet and tenths. It is fastened to the upstream side of a small bridge and is read once each day by E. J. Coop. A meter measurement on Schell ditch 200 feet below its intake gave a discharge of about 7 second-feet, which is said to be its usual flow. In computing the estimated monthly discharge of Stanislaus River for 1904, a mean daily discharge of 7 second-feet has been used as the capacity of Schell ditch.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Stanislaus Water Company's ditch at Knights Ferry, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
July 22	O. W. Peterson	3.45	105
August 24	do	3.25	91
August 24	do	2.95	77
August 24	do	2.80	68
August 24	do	2.35	45
August 24	do	2.20	38

Mean daily gage height, in feet, of Stanislaus Water Company's ditch below Schell ditch intake, at Knights Ferry, Cal., for 1904.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		3.45	3.50	3.40	3.30	2.55	1.90
2		2.75	3.45	3.35	3.35	2.40	2.00
3		1.50	3.40	3.30	3.30	2.40	1.90
4		1.70	3.35	3.35	3.35	2.25	1.90
5		2.90	.00	3.30	3.25	2.20	1.80
6		3.25	.00	3.30	2.90	2.25	2.20
7		3.45	.00	3.30	2.95	2.15	2.00
8		3.60	.00	3.20	2.70	2.20	2.15
9		3.45	3.10	3.10	2.95	2.00	2.10
10		3.55	3.35	3.10	2.95	2.00	2.10
11	3.45	3.45	3.40	3.25	2.60	2.00	2.15
12	3.50	3.45	3.35	3.20	2.60	1.90	1.80
13	3.60	3.30	3.35	3.20	2.60	1.95	2.30
14	3.50	5.25	3.40	3.00	2.45	1.90	1.85
15	3.50	3.35	3.35	3.10	2.25	1.85	1.80
16	3.50	3.30	3.30	3.00	2.30	1.90	1.90
17	3.65	3.30	3.30	3.40	2.20	2.10	1.75
18	3.60	3.50	3.35	3.50	2.20	2.10	2.00
19	3.60	3.50	3.35	3.40	2.10	1.95	1.85
20	3.60	3.50	3.30	3.40	2.35	2.15	1.65
21	3.60	3.50	3.30	3.30	2.30	1.95	1.60
22	3.55	3.50	3.30	3.45	2.25	1.90	1.70
23	3.60	3.40	3.30	3.35	2.45	1.85	1.90
24	3.60	3.20	3.30	3.40	2.55	2.00	1.50
25	3.30	3.40	3.30	3.40	2.40	1.90	2.00
26	3.60	3.45	3.30	3.25	2.45	1.90	1.60
27	3.60	3.55	3.40	3.10	2.50	2.10	1.65
28	3.55	3.50	3.10	2.95	2.45	1.75	1.80
29	3.50	3.50	3.30	3.30	2.40	2.10	1.90
30	3.45	3.45	3.35	3.30	2.50	1.70	1.75
31		3.40	3.35		2.50		2.30

Rating table for Stanislaus Water Company's ditch below Schell ditch intake, at Knights Ferry, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.50	12	2.10	33	2.70	63	3.20	90
1.60	15	2.20	38	2.80	68	3.30	96
1.70	18	2.30	43	2.90	73	3.40	102
1.80	21	2.40	48	3.00	78	3.50	108
1.90	24	2.50	53	3.10	84	3.60	114
2.00	28	2.60	58				

Monthly estimates of flow included in those for Stanislaus River given on page 154.

TUOLUMNE RIVER AT LAGRANGE, CAL.

This station was established August 29, 1895, by J. B. Lippincott. It is located at the wagon bridge in the town of Lagrange, Cal. It is below the high dam of the Turlock and Modesto irrigation districts, and also below the head of the canal of the Lagrange Ditch and Hydraulic Mining Company, which diverts water from the left bank of the river 15 miles above the Lagrange dam. During 1903 this canal was being repaired and for the greater part of the year carried no water; for the remainder of the year it carried only enough water to keep the flumes wet. The gage is a vertical timber fastened to the right abutment. It is read twice each day by Miss Annie P. McGinn. Discharge measurements are made from the bridge to which the gage is attached. The initial point for soundings is at the south end of the trestle approach to bridge, on the left bank of the river.

The channel is straight for 400 feet above and 600 feet below the station. It is broken by two iron piers and has a width at ordinary stages of 300 feet. During the season of low water all the water is taken out by the canals above the station. The bed of the stream is composed of gravel and is fairly permanent. The current is swift at high stages and very sluggish during low water. The discharge has gradually increased each year for the same gage heights. Both banks are high and not subject to overflow.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Tuolumne River at Lagrange, Cal., for 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 21	F. W. Huber	4.15	143
March 26	E. C. Murphy, W. B. Clapp, and S. G. Bennett	6.90	4,750
May 9	S. G. Bennett	8.64	10,531
June 8	O. W. Peterson	8.28	9,656
July 21	do	5.73	1,986
August 23	do	3.25	4.6

Mean daily gage height, in feet, of Tuolumne River at Lagrange, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.50	3.50	6.45	7.15	6.70	8.30	7.05	5.00	(3.50)	6.20	5.50	4.70
2	4.50	3.50	6.25	6.95	6.55	8.00	6.85	4.95	(3.45)	6.50	5.45	4.70
3	4.45	3.50	6.20	6.80	6.55	9.20	6.65	4.85	3.50	6.10	5.40	4.70
4	4.40	3.50	6.20	6.65	6.90	8.80	6.60	4.70	3.00	6.00	5.35	4.70
5	4.35	4.60	6.25	6.60	7.30	8.60	6.55	4.50	3.00	5.85	5.30	4.70
6	4.30	4.10	6.15	6.85	8.10	8.95	6.65	4.40	3.10	5.90	5.30	4.65
7	4.30	4.50	6.30	7.20	8.70	8.70	6.80	4.70	3.10	7.35	5.20	4.60
8	4.25	4.45	6.60	7.35	8.70	8.20	6.60	4.55	3.10	7.45	5.15	4.60
9	4.30	4.30	6.60	7.35	8.80	8.30	6.15	4.30	3.10	7.25	5.10	4.60
10	4.25	4.20	7.15	7.60	9.00	8.45	6.10	4.20	3.10	7.10	5.10	4.55
11	4.30	4.10	7.40	7.85	9.05	8.50	6.00	3.80	3.10	9.80	5.05	4.55
12	4.35	5.30	6.80	8.10	9.50	8.55	6.00	3.70	3.10	8.20	5.00	4.50
13	4.30	6.90	6.55	8.35	9.50	8.70	5.85	3.25	3.10	6.85	5.00	4.50
14	4.20	5.70	6.35	8.35	9.65	8.50	5.75	3.25	3.10	6.50	5.00	4.50
15	4.20	5.35	6.45	7.70	9.45	8.50	5.55	3.20	3.10	6.50	4.90	4.50
16	4.20	9.35	6.40	7.50	9.45	8.50	5.45	4.00	3.10	5.90	4.90	4.50
17	4.20	7.15	6.50	7.40	9.55	8.30	5.45	4.70	3.10	5.60	4.85	4.50
18	4.40	6.35	7.50	7.30	8.45	8.20	5.50	4.50	3.10	5.50	4.80	4.45
19	4.40	5.90	7.70	8.45	8.35	8.10	5.70	4.00	3.10	5.50	4.80	4.45
20	4.30	5.60	10.30	7.45	8.35	8.05	5.85	3.70	3.10	5.50	4.80	4.40
21	4.05	5.65	8.40	7.10	8.55	8.00	5.80	3.25	3.10	5.50	4.75	4.40
22	4.10	6.25	7.75	7.00	9.50	8.00	5.80	3.20	3.10	5.50	4.75	4.35
23	4.05	8.45	8.10	6.70	10.25	7.90	5.90	3.20	3.25	5.50	4.70	4.35
24	4.20	8.50	7.60	6.55	10.15	7.90	5.90	3.20	5.05	5.50	4.70	4.35
25	4.20	9.80	7.20	6.65	9.85	7.65	5.60	3.20	5.45	5.50	4.70	4.40
26	3.90	7.80	6.95	6.90	8.70	7.35	5.30	3.20	5.85	5.50	4.70	4.50
27	3.80	8.70	6.85	6.80	8.30	7.25	5.15	3.20	5.55	5.50	4.70	4.50
28	3.65	7.60	7.30	6.60	8.30	7.25	5.00	3.10	5.50	5.50	4.70	4.50
29	3.50	6.90	9.10	6.60	8.60	7.35	4.95	4.00	5.50	5.50	4.70	4.50
30	3.50	.....	8.05	6.55	8.70	7.25	4.80	(4.00)	6.10	5.50	4.70	4.50
31	3.50	.....	7.45	.....	8.35	.....	5.00	(4.00)	.....	5.50	.....	6.20

NOTE.—Gage heights in parenthesis are estimated.

Rating table for Tuolumne River at Lagrange, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.20	1	4.50	360	5.80	2,100	7.20	5,700
3.30	10	4.60	430	5.90	2,300	7.40	6,300
3.40	20	4.70	510	6.00	2,500	7.60	7,000
3.50	30	4.80	600	6.10	2,700	7.80	7,700
3.60	40	4.90	700	6.20	2,900	8.00	8,400
3.70	50	5.00	810	6.30	3,150	8.20	9,100
3.80	70	5.10	930	6.40	3,400	8.40	9,900
3.90	90	5.20	1,060	6.50	3,650	8.60	10,700
4.00	110	5.30	1,200	6.60	3,900	8.80	11,500
4.10	150	5.40	1,350	6.70	4,200	9.00	12,300
4.20	200	5.50	1,520	6.80	4,500	9.50	14,300
4.30	250	5.60	1,710	6.90	4,800	10.00	16,300
4.40	300	5.70	1,900	7.00	5,100		

Estimated monthly discharge of Tuolumne River, including Turlock and Modesto canals, at Lagrange, Cal., for 1904.[a]

[Drainage area, 1,501 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	538	331	434	26,686	0.29	0.33
February	15,882	311	4,127	237,388	2.75	2.97
March	17,665	3,275	5,949	365,790	3.96	4.56
April	10,606	4,374	6,406	381,183	4.27	4.76
May	17,850	4,405	11,692	718,913	7.79	8.98
June	13,858	6,130	9,576	569,812	6.38	7.12
July	5,530	1,046	2,970	182,618	1.98	2.28
August	1,291	325	769	47,284	.51	.59
September	3,172	97	652	38,797	.43	.48
October	15,855	1,520	3,535	217,359	2.36	2.72
November	1,520	510	808	48,079	.54	.60
December	2,900	275	463	28,469	.31	.36
The year	17,850	97	3,948	2,862,378	2.63	35.75

[a] Small amount of water diverted by mining ditch not included in this estimate.

TURLOCK CANAL AT LAGRANGE, CAL.

The Turlock canal, the property of the Turlock Irrigation district, takes water from the left bank of the Tuolumne River at the Lagrange dam. This canal was designed to carry 1,500 second-feet and to irrigate a large area of fertile land in the vicinity of Turlock and Ceres, Stanislaus County, Cal. During 1898 water was first turned into the canal in small quantities and used for puddling the banks. A record of the gage height has been kept since July, 1899. Meter measurements are made when the gaging station on the Tuolumne River at Lagrange is visited, and Morgan flume, or Flume No. 2, has been rated. It is 13.75 feet in width. The observer is J. L. Montgomery.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Turlock canal at Lagrange, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 21	F. W. Huber	1.30	49
May 8	S. G. Bennett	4.78	455
May 8	do	3.70	291
May 8	do	2.60	153
May 8	do	1.98	80
May 9	do	1.70	54
June 8	O. W. Peterson	5.08	496
August 22	do	3.90	338

Mean daily gage height, in feet, of Turlock canal at Lagrange, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.00	2.40	4.15	4.00	4.75	5.00	0.00	0.80	3.20	4.40	0.00	0.00
2	.00	3.25	4.15	4.30	4.70	4.95	[a] 2.60	3.60	2.60	4.40	.00	.00
3	.00	3.15	4.15	4.40	4.75	5.05	3.60	4.05	2.80	4.40	.00	.00
4	.00	3.15	4.25	4.40	4.80	5.00	4.10	4.50	2.60	4.40	.00	.00
5	.00	3.60	4.25	4.40	4.80	5.10	4.50	4.60	2.70	4.40	.00	.00
6	.00	3.60	4.25	4.45	4.85	5.10	3.35	4.60	2.60	3.90	.00	.00
7	.00	3.60	2.10	4.40	4.80	5.15	3.90	4.60	2.50	4.40	.00	.00
8	.00	3.60	[b] .00	4.50	4.80	5.10	4.90	4.60	2.40	4.40	.00	.00
9	.00	3.30	.00	4.60	4.70	5.10	4.80	4.60	2.40	4.40	.00	.00
10	.00	3.60	.00	4.60	4.80	4.00	4.80	4.60	2.30	3.70	.00	.00
11	.00	3.60	.00	4.60	4.90	.90	4.85	4.60	2.20	4.00	.00	.00
12	.00	3.40	.00	4.65	4.90	4.90	4.85	4.60	2.20	4.40	.00	.00
13	.00	3.80	[a] .85	4.70	4.95	[b] .00	3.95	4.60	2.20	4.40	.00	.00
14	.00	3.85	3.10	4.70	4.95	.00	4.55	4.15	2.20	4.40	.00	.00
15	.00	3.50	3.50	4.70	4.95	.00	4.60	4.10	2.15	4.40	.00	.00
16	.00	3.75	2.05	4.70	4.95	.00	4.60	4.10	2.15	4.30	.00	.00
17	.00	4.00	[b] .00	4.70	5.00	.00	4.80	4.60	2.55	4.30	.00	.00
18	.00	4.00	.00	4.70	5.00	.00	4.85	4.60	2.55	3.60	.00	.00
19	.00	4.00	.00	3.80	4.95	.00	.80	4.70	2.65	3.30	.00	.00
20	[a] 1.50	4.00	.00	4.70	5.00	.00	.80	4.60	2.60	2.80	.00	.00
21	1.50	4.00	.00	4.70	5.00	.00	.80	4.50	2.50	[b] .00	.00	.00
22	1.10	3.80	.00	4.70	5.05	.00	.80	4.00	2.30	.00	.00	.00
23	2.00	4.00	.00	4.70	5.00	.00	.40	3.60	2.30	.00	.00	.00
24	2.00	3.60	.00	4.70	5.00	.00	1.30	3.50	3.50	.00	.00	.00
25	2.00	3.80	.00	4.80	5.00	.00	2.60	3.45	3.20	.00	.00	.00
26	2.45	2.55	.00	4.70	5.05	.00	4.00	3.45	2.00	.00	.00	.00
27	3.25	3.20	.00	4.75	5.05	.00	4.05	3.30	4.40	.00	.00	.00
28	3.10	4.15	.00	4.70	5.05	.00	4.05	3.45	4.40	.00	.00	.00
29	3.25	4.15	.00	4.75	5.05	.00	4.70	3.45	4.40	.00	.00	.00
30	3.25	.....	.00	4.75	5.10	.00	4.80	3.60	4.40	.00	.00	.00
31	3.15	.....	[a] 3.00	.....	5.00	.....	.80	3.20	.....	.00	.....	.00

[a] Water turned in. [b] Water turned off.

Rating table for Turlock canal at Lagrange, Cal., from January 1 to July 1, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.00	0.0	1.40	30	2.80	179	4.20	375
.10	.5	1.50	37	2.90	192	4.30	390
.20	1.	1.60	45	3.00	205	4.40	405
.30	1.5	1.70	55	3.10	218	4.50	420
.40	2.	1.80	65	3.20	231	4.60	436
.50	2.5	1.90	75	3.30	244	4.70	452
.60	3	2.00	85	3.40	257	4.80	468
.70	4	2.10	96	3.50	270	4.90	484
.80	6	2.20	107	3.60	285	5.00	500
.90	9	2.30	118	3.70	300	5.10	516
1.00	12	2.40	129	3.80	315	5.20	532
1.10	16	2.50	141	3.90	330	5.30	548
1.20	20	2.60	153	4.00	345	5.40	564
1.30	25	2.70	166	4.10	360	5.50	580

Rating table for Turlock canal at Lagrange, Cal., from July 2 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.40	1	1.60	42	2.80	178	4.00	355
.50	2	1.70	50	2.90	192	4.10	372
.60	3	1.80	58	3.00	206	4.20	389
.70	4	1.90	67	3.10	220	4.30	406
.80	6	2.00	76	3.20	235	4.40	423
.90	9	2.10	86	3.30	250	4.50	440
1.00	12	2.20	97	3.40	265	4.60	457
1.10	16	2.30	109	3.50	280	4.70	474
1.20	20	2.40	122	3.60	295	4.80	491
1.30	24	2.50	136	3.70	310	4.90	508
1.40	29	2.60	150	3.80	325	5.00	525
1.50	35	2.70	164	3.90	340		

Monthly estimates are included in those for Tuolumne River given on page 158.

MODESTO CANAL AT LAGRANGE, CAL.

The Modesto canal is the property of the Modesto irrigation district. The water is diverted from the right side of the Tuolumne River at the Lagrange dam. This canal was designed to carry 660 second-feet and to irrigate land in the vicinity of Modesto, Stanislaus County, Cal. The principal part of the construction work was done on this canal prior to 1892, but on account of litigation the canal was not completed until April, 1903.

On April 26, 1903, a gage rod was set in and a rating made of Indian Hill flume, near Lagrange, Cal. From May 10 to June 3, and from June 10 to June 25, inclusive, boards were placed in the flumes to back the water up and keep the flumes saturated. During this time gage heights were obtained by taking the depth of the water in the canal below Indian Hill flume. The observer is Annie P. McGinn.

On July 12, 1904, the station was moved to the flume near the intake. This was done so that more gage readings and explanations of their fluctuations could be obtained, by having J. L. Montgomery, the regulator of the gates at the intake, act as gage observer. This flume is 11.85 feet in width. The gage is graduated to feet and tenths.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Modesto canal at Lagrange, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 21 [a]	F. W. Huber	2.55	170
March 26 [a]	E. C. Murphy, W. B. Clapp, and S. G. Bennett	2.60	196
May 9 [a]	S. G. Bennett	2.78	218
May 9 [b]	do	1.27	64
May 9 [b]	do	1.90	119
May 9 [b]	do	.65	24
June 8 [a]	O. W. Peterson	1.60	86
July 21 [b]	do	3.10	280
August 22 [b]	do	2.50	186

[a] Measurement made at Indian Hill flume.
[b] Measurement made at flume near intake.

Mean daily gage height, in feet, of Modesto canal at Lagrange, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.50	2.30	0.95	[a] 0.00	2.20	2.80	3.20	0.00	1.80	[a] 0.00	0.00	0.00
2	2.50	2.30	1.20	2.30	2.50	2.80	3.20	3.10	1.50	.00	.00	.00
3	2.50	2.30	1.70	2.30	2.70	3.00	3.20	3.15	1.50	.00	.00	.00
4	2.50	2.30	1.80	2.30	2.70	3.00	3.20	3.10	1.40	.00	.00	.00
5	2.50	2.60	1.80	2.30	2.70	3.00	3.20	3.05	1.50	.00	.00	.00
6	2.50	2.60	1.80	2.30	2.70	3.00	3.20	3.05	1.40	.00	.00	.00
7	2.50	2.60	2.10	2.30	2.70	3.00	3.20	3.10	1.30	.00	.00	.00
8	2.50	2.60	2.10	2.30	2.75	2.20	3.20	3.10	1.20	.00	.00	.00
9	2.50	2.60	2.10	2.30	2.00	2.20	3.20	3.05	1.20	.00	.00	.00
10	2.50	2.60	1.70	2.30	1.25	3.00	3.20	3.10	1.10	.00	.00	.00
11	2.50	2.60	1.70	2.40	2.30	3.15	3.20	3.10	.00	.00	.00	.00
12	2.50	2.70	2.00	[a] .10	2.70	3.20	3.20	3.10	.00	.00	.00	.00
13	2.50	1.60	2.30	1.20	2.90	3.10	[c] 3.25	2.95	.00	.00	.00	.00
14	2.50	[a] .05	2.30	2.35	2.90	3.10	3.25	2.70	.00	.00	.00	.00
15	2.50	.00	2.30	.45	2.90	3.15	3.25	2.65	.95	.00	.00	.00
16	2.50	.00	2.30	2.30	2.90	3.20	3.25	3.20	.95	.00	.00	.00
17	2.50	.00	2.30	2.30	2.90	3.20	3.25	3.15	1.35	.00	.00	.00
18	2.50	.00	2.40	2.60	2.90	3.20	3.25	3.15	1.35	.00	.00	.00
19	2.50	.00	2.40	2.60	2.90	3.20	3.25	3.20	1.45	.00	.00	.00
20	2.50	.00	2.40	2.60	2.90	3.20	3.25	3.20	1.40	.00	.00	.00
21	2.40	.00	2.40	2.60	1.80	3.20	3.10	2.90	1.30	.00	.00	.00
22	2.40	.00	2.60	2.65	[a] .00	3.20	3.15	2.60	1.10	.00	.00	.00
23	2.50	.00	2.60	2.70	1.35	3.20	.00	2.30	1.10	.00	.00	.00
24	2.60	.40	2.60	2.70	1.45	3.20	.60	2.20	1.85	.00	.00	.00
25	2.60	.80	2.65	2.70	1.85	3.20	.60	2.10	2.00	.00	.00	.00
26	2.60	.75	2.50	2.70	2.35	3.20	3.00	2.10	2.00	.00	.00	.00
27	2.60	.80	2.50	2.70	2.80	3.20	3.00	2.00	2.00	.00	.00	.00
28	2.50	.80	1.40	1.90	3.00	3.20	3.00	1.10	2.00	.00	.00	.00
29	2.30	.85	2.35	[b] 1.00	2.80	3.20	3.00	2.20	2.00	.00	.00	.00
30	2.30	.....	2.60	2.20	2.80	3.20	3.05	1.90	1.05	.00	.00	.00
31	2.30	.....	2.60	.....	2.80	.....	3.00	1.90	.....	.00	.....	.00

[a] Shut off water to repair canal.
[b] Water lowered to repair canal.
[c] New station established at flume near intake.

Rating table for Modesto canal at Lagrange, Cal., from July 13 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.00	0	0.90	38	1.80	112	2.70	200
.10	2	1.00	45	1.90	121	2.80	210
.20	4	1.10	53	2.00	130	2.90	220
.30	7	1.20	61	2.10	140	3.00	230
.40	11	1.30	69	2.20	150	3.10	241
.50	16	1.40	77	2.30	160	3.20	252
.60	21	1.50	85	2.40	170	3.30	263
.70	26	1.60	94	2.50	180	3.40	274
.80	32	1.70	103	2.60	190	3.50	285

Monthly estimates are included in those for Tuolumne River given on page 158.

MERCED RIVER ABOVE MERCED FALLS, CAL.

The measurement of this stream was undertaken in response to numerous requests from mining and irrigation interests. The midsummer flow of the stream is less than the combined capacity of the irrigation and power canals taking water in the vicinity of Snelling.

The station was established April 6, 1901, by H. H. Henderson. It is located 1 mile above Merced Falls. The gage is made of 2 by 4 inch board, painted white, and graduated to feet and tenths, and is bolted to iron stakes driven in the bed of the stream. The gage is read twice each day by Charles Siegfeldt. Discharge measurements are made from a car and cable. Both banks are high and rocky and are not subject to overflow. The bed of the stream is composed of gravel and is subject to change. The bench mark is ¾-inch round iron bolt set 10 inches in the slate rock on the right bank of the river. It has an elevation of 69.201 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Merced River above Merced Falls, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 10	H. H. Henderson	8.20	239
January 24	do	8.15	204
February 4	do	8.20	199
February 25	do	11.62	3,457
February 28	do	11.50	3,268
March 6	do	9.80	1,203
March 29	do	12.25	4,683
April 20	do	11.80	3,357

Discharge measurements of Merced River above Merced Falls, Cal., in 1904—Continued.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
May 29	H. H. Henderson	12.80	5,424
June 16	do	11.60	3,165
July 1	do	10.20	1,414
August 7	do	8.35	214
August 23	O. W. Peterson	8.32	209
August 28	H. H. Henderson	8.20	182
September 12	do	7.90	74
September 27	do	9.50	928
October 9	do	11.90	3,516
October 23	do	9.50	995
November 25	do	8.60	314
December 4	do	8.60	303

Mean daily gage height, in feet, of Merced River above Merced Falls, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	8.20	8.20	10.15	10.65	10.85	12.35	10.30	8.80	8.20	9.90	9.15	8.70
2	8.20	8.20	9.90	10.35	10.65	12.30	10.15	8.95	8.05	11.25	9.10	8.70
3	8.20	8.25	9.85	10.45	10.55	13.05	10.10	9.15	8.05	10.35	9.10	8.70
4	8.25	8.35	9.90	10.30	11.00	12.70	9.95	8.95	8.05	10.15	9.10	8.65
5	8.20	8.65	9.90	10.30	11.55	12.55	9.90	8.95	8.00	10.15	9.05	8.60
6	8.10	8.55	9.80	10.50	12.40	12.50	9.95	9.15	8.00	10.40	9.00	8.60
7	8.10	8.60	9.75	10.65	13.35	12.35	9.90	9.25	8.00	11.45	8.95	8.50
8	8.05	8.50	9.95	11.00	12.60	11.90	9.90	9.00	8.00	11.15	8.90	8.50
9	8.10	8.50	10.00	10.80	13.05	11.85	9.85	8.85	8.00	10.70	8.90	8.50
10	8.10	8.50	10.20	11.55	13.30	11.85	9.65	8.75	8.00	10.40	8.90	8.50
11	8.20	8.40	11.65	11.60	13.55	11.75	9.55	8.65	7.95	11.25	8.85	8.50
12	8.10	8.45	10.70	11.85	13.95	11.75	9.45	8.60	7.90	11.70	8.80	8.40
13	8.10	10.45	10.30	12.10	13.65	11.70	9.45	8.55	7.90	10.85	8.80	8.50
14	8.05	9.30	10.10	12.40	14.10	11.55	9.35	8.45	7.90	10.50	8.80	8.50
15	8.15	9.05	10.15	12.15	13.70	11.45	9.30	8.40	7.90	10.25	8.80	8.50
16	8.10	12.45	10.20	11.40	13.70	11.50	9.25	8.80	7.85	9.95	8.80	8.45
17	8.10	10.65	10.10	11.30	13.70	11.40	9.15	8.80	7.90	9.80	8.80	8.40
18	8.15	9.80	10.60	11.30	13.90	11.30	9.10	8.75	8.15	9.70	8.80	8.40
19	8.30	9.35	10.90	12.10	12.50	11.15	9.20	8.60	8.20	9.55	8.80	8.40
20	8.25	9.15	(11.30)	11.55	12.60	11.20	9.30	8.50	8.20	9.50	8.70	8.40
21	8.20	9.10	11.65	11.25	12.80	11.00	9.25	8.40	8.15	9.45	8.70	8.40
22	8.20	9.35	11.30	11.25	13.15	10.90	9.20	8.40	8.15	9.45	8.70	8.35
23	8.20	9.90	13.00	10.90	13.65	10.95	9.35	8.35	8.10	9.50	8.70	8.40
24	8.15	10.80	11.75	10.60	13.55	10.85	9.25	8.30	8.35	9.55	8.60	8.45
25	8.15	11.35	11.60	10.85	13.55	10.65	9.20	8.30	9.90	9.45	8.60	8.80
26	8.20	10.75	11.10	11.15	12.75	10.55	9.15	8.30	9.90	9.45	8.60	8.55
27	8.35	12.30	10.65	11.05	12.30	10.50	9.10	8.25	9.55	9.40	8.60	8.45
28	8.20	11.60	11.15	11.25	12.45	10.45	9.10	8.20	9.30	9.35	8.60	8.50
29	8.20	10.50	12.40	10.60	12.65	10.40	9.00	8.20	9.45	9.30	8.85	8.50
30	8.20	.....	11.55	10.60	12.50	10.35	8.90	8.30	9.80	9.30	8.75	8.50
31	8.20	.....	11.05	.....	12.45	.....	8.80	8.25	.....	9.20	.....	10.35

Rating table for Merced River above Merced Falls, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
7.80	65	9.00	565	10.10	1,450	11.40	3,000
7.90	95	9.10	630	10.20	1,550	11.60	3,300
8.00	130	9.20	700	10.30	1,650	11.80	3,630
8.10	165	9.30	770	10.40	1,760	12.00	4,000
8.20	200	9.40	845	10.50	1,870	12.20	4,400
8.30	235	9.50	920	10.60	1,980	12.40	4,800
8.40	270	9.60	1,000	10.70	2,100	12.60	5,210
8.50	310	9.70	1,085	10.80	2,220	12.80	5,630
8.60	355	9.80	1,170	10.90	2,340	13.00	6,050
8.70	400	9.90	1,260	11.00	2,460	13.50	7,200
8.80	450	10.00	1,350	11.20	2,720	14.00	8,500
8.90	505						

Estimated monthly discharge of Merced River above Merced Falls, Cal., for 1904.

[Drainage area, 1,090 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	252	148	189	11,621	0.17	0.20
February	4,900	200	1,240	71,326	1.14	1.23
March	6,050	1,128	2,265	139,269	2.08	2.40
April	4,800	1,650	2,708	161,137	2.48	2.77
May	8,780	1,925	5,797	356,444	5.32	6.13
June	6,160	1,705	3,292	195,888	3.02	3.37
July	1,650	450	909	55,892	.83	.96
August	735	200	380	23,365	.35	.40
September	1,260	80	325	19,339	.30	.33
October	3,460	700	1,511	92,908	1.39	1.60
November	665	355	471	28,026	.43	.48
December	1,705	252	361	22,197	.33	.38
The year	8,780	80	1,621	1,177,412	1.49	20.25

SAN JOAQUIN RIVER AT HERNDON, CAL.

The gage rod at this station was established by the engineering department of the Southern Pacific Railway Company in 1879. The old trestle bridge was torn down by the railroad company during 1899

and a new iron structure was erected in its place. A new gage rod, set to the datum of the old gage, was bolted to the western side of the central concrete pier. The bench mark is a nail in a post at the south end of the bridge on the west side, 0.2 foot above the ground, and marked "B. M." It is at an elevation of 24.12 feet above gage datum. The channel for some distance above and below the bridge is straight, and the water has a uniform velocity. The right bank is high, rocky, and steep. The bed of the stream is composed of small gravel and shifting sand. Because of the continual changes in the cross section, which were increased by a side channel breaking through the gravel pits on the left bank of the river just above the gaging station, meter measurements were discontinued at this station at the end of 1901.

The river stage record for 1904 has been furnished by William Hood, chief engineer of the Southern Pacific Railway Company. G. G. Nelson was the observer.

Mean daily gage height, in feet, of San Joaquin River at Herndon, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.20	2.20	4.00	5.30	5.50	8.50	6.00	4.20	3.20	4.00	3.60	3.20
2	2.20	2.20	4.00	5.30	5.40	8.50	6.00	4.00	3.20	4.20	3.50	3.20
3	2.20	2.20	4.00	5.00	5.20	10.00	5.80	4.00	3.20	4.40	3.50	3.20
4	2.20	2.20	4.00	5.00	5.20	9.50	5.80	4.20	3.20	4.50	3.50	3.10
5	2.20	2.20	4.00	5.00	6.00	8.80	5.60	4.20	3.20	4.50	3.40	3.10
6	2.20	2.20	4.00	5.00	6.50	9.00	5.50	4.20	3.00	4.80	3.40	3.10
7	2.20	2.20	4.00	5.20	6.70	8.80	5.50	4.20	3.00	5.70	3.40	3.10
8	2.20	2.20	4.00	5.50	9.00	8.00	5.50	4.20	3.00	5.70	3.40	3.10
9	2.20	2.20	4.20	6.20	8.80	7.70	5.50	4.20	3.00	5.50	3.30	3.10
10	2.20	2.20	4.20	6.80	9.00	7.50	5.20	4.30	3.00	5.50	3.30	3.10
11	2.20	2.20	6.50	7.00	9.50	7.50	5.10	4.30	3.00	5.30	3.30	3.10
12	2.20	2.20	6.80	7.20	9.70	7.50	5.00	4.10	3.00	8.00	3.30	3.10
13	2.20	2.20	6.30	7.20	10.00	7.70	5.00	4.00	2.80	6.50	3.20	3.10
14	2.20	2.20	4.50	7.30	11.20	8.00	5.00	4.00	2.80	5.50	3.20	3.10
15	2.20	2.20	4.20	7.30	11.00	7.80	5.00	4.00	2.80	5.00	3.20	3.10
16	2.20	2.30	4.20	6.80	10.70	8.00	5.00	4.00	2.80	4.70	3.20	3.10
17	2.20	5.50	4.20	6.50	10.50	7.80	5.00	4.00	2.80	4.30	3.20	3.10
18	2.20	4.00	5.00	6.30	10.20	7.50	5.00	4.00	2.80	4.30	3.20	3.10
19	2.20	3.00	4.70	6.30	9.50	7.40	5.00	4.00	2.80	4.30	3.20	3.10
20	2.50	3.20	8.50	7.30	8.50	7.20	5.00	4.00	2.80	4.20	3.20	3.10
21	2.50	3.20	6.50	6.50	8.80	7.00	5.00	3.80	2.80	4.00	3.20	3.10
22	2.40	3.20	6.00	6.30	9.30	7.00	4.80	3.70	2.80	4.00	3.20	3.10
23	2.30	3.50	5.50	6.30	10.20	7.00	4.60	3.70	2.80	4.00	3.20	3.10
24	2.30	6.00	5.30	5.50	11.00	6.70	5.00	3.60	2.80	4.00	3.20	3.10
25	2.30	6.30	5.00	6.50	10.50	6.50	5.00	3.60	5.00	4.00	3.20	3.00
26	2.30	5.80	5.00	5.50	9.50	6.20	5.00	3.50	6.80	4.00	3.20	3.00
27	2.30	6.00	4.80	5.30	8.60	6.00	5.00	3.30	5.00	3.90	3.20	3.00
28	2.20	5.30	5.00	5.30	8.50	6.00	4.70	3.30	4.80	3.90	3.20	3.00
29	2.20	4.30	8.00	5.50	9.00	6.00	4.60	3.30	4.00	3.80	3.20	3.00
30	2.20	.....	6.00	5.50	9.00	6.00	4.40	3.20	4.00	3.80	3.20	3.00
31	2.20	.....	5.50	.....	8.70	.....	4.30	3.20	.....	3.70	.....	3.20

KING RIVER NEAR SANGER, CAL.

This station was established September 3, 1895, by J. B. Lippincott. It is located 15 miles east of Sanger, Cal., near the mouth of the canyon, and is above all diversions. An automatic river stage register was installed April 18, 1903. There is also an inclined wooden gage near by from which readings were formerly taken and which is now used in checking the self-recording gage. O. G. Williams reads the gage once each day and also examines the automatic gage to see that it is in proper working order. The mean daily gage height is determined from the register sheets by the use of planimeter. Discharge measurements are made by means of a cable and car. The initial point for soundings is an eyebolt inbedded in concrete on the right bank of river. The channel is nearly straight for 300 feet above and below the station, and has a width of 180 feet at ordinary stages. The bed of the stream is composed of gravel and small bowlders and changes but little. The right bank is high and not subject to overflow. The left bank is subject to overflow during extreme high water. The current is swift. A bench mark 18.045 feet above the zero of the gage, 11 feet northwest of a sycamore tree at the upper end of the rod, is marked with a cross on the rock.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of King River near Sanger, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 30	F. W. Huber	3.94	210
March 25	E. C. Murphy and S. G. Bennett	6.60	2,038
April 27	A. C. Lootz	7.30	2,792
May 30	do	10.00	10,034
June 6	O. W. Peterson	10.85	12,827
June 30	F. R. S. Buttemer	7.80	3,704
July 19	do	6.02	1,468
July 27	do	6.50	2,008
August 8	do	6.35	1,762
August 16	do	5.60	1,292
September 8	do	4.20	312
September 29	do	6.37	1,740
October 7	do	7.25	2,704
October 15	do	6.70	2,138
October 29	do	5.47	1,054
November 8	do	4.88	712
November 17	do	4.60	520
November 25	do	4.40	445
December 2	do	4.42	445
December 9	do	4.30	368

Mean daily gage height, in feet, of King River near Sanger, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.85	3.90	5.30	7.00	7.35	10.15	7.55	5.95	4.50	6.30	5.30	4.50
2	3.85	3.90	5.30	6.95	7.20	10.40	7.45	6.15	4.45	6.40	5.30	4.45
3	3.85	3.90	5.45	6.90	7.30	11.20	7.25	5.95	4.40	6.45	5.35	4.45
4	3.85	3.90	5.55	6.75	7.75	10.95	7.15	5.75	4.40	6.50	5.20	4.40
5	3.85	4.00	5.50	6.90	8.45	10.75	7.15	5.65	4.35	6.65	5.10	4.30
6	3.90	4.05	5.30	7.10	9.15	10.65	7.15	5.70	4.30	7.30	5.05	4.25
7	3.80	5.00	5.40	7.40	9.90	10.30	7.20	6.05	4.25	7.35	5.00	4.20
8	3.80	4.10	5.55	7.60	10.05	9.70	7.20	6.25	4.25	7.35	4.95	4.20
9	3.80	4.00	5.65	7.90	10.25	9.80	6.95	6.45	4.20	7.35	4.90	4.25
10	3.80	3.90	6.05	8.20	10.45	9.85	6.75	6.20	4.15	6.95	4.90	4.25
11	3.80	4.00	6.90	8.45	10.70	10.00	6.55	5.85	4.15	8.05	4.85	4.20
12	3.80	4.05	5.90	8.65	10.95	10.05	6.60	5.55	4.10	7.95	4.80	4.20
13	3.80	4.40	(5.90)	8.95	11.15	10.10	6.45	5.35	4.10	7.15	4.80	4.30
14	3.80	4.35	(5.90)	8.75	11.25	9.80	6.30	5.40	4.10	6.80	4.75	4.20
15	3.80	4.25	(5.90)	8.75	11.25	9.70	6.15	5.55	4.10	6.65	4.70	4.20
16	3.80	4.50	6.00	8.40	11.40	9.65	6.05	5.65	4.35	6.45	4.75	4.20
17	3.80	6.90	5.95	8.00	11.45	9.45	6.00	5.65	4.35	6.20	4.75	4.20
18	3.90	5.25	6.20	8.10	11.30	9.25	6.00	5.40	4.35	6.05	4.65	4.10
19	3.90	5.00	6.65	8.50	10.30	9.00	6.05	5.20	4.30	5.95	4.65	4.10
20	3.80	4.70	8.65	8.10	10.05	9.00	6.00	5.10	4.30	5.85	4.55	4.15
21	3.70	4.70	7.20	7.65	10.15	8.60	6.00	4.95	4.30	5.85	4.60	4.15
22	3.80	5.05	6.65	7.65	10.45	8.45	6.00	4.85	4.25	5.80	4.55	4.20
23	3.90	5.05	9.70	7.25	11.10	8.50	6.25	4.75	4.25	5.80	4.55	4.15
24	4.00	5.35	7.50	7.15	11.20	8.30	6.35	4.80	5.60	5.80	(4.50)	4.15
25	3.95	(5.50)	6.85	7.45	11.25	8.10	6.25	4.85	7.50	5.75	4.40	4.45
26	3.95	5.60	6.55	7.65	10.65	7.85	6.30	4.80	6.70	5.70	4.40	4.25
27	3.95	5.40	6.55	7.35	9.95	7.80	6.40	4.85	6.25	5.60	4.40	4.20
28	3.90	6.40	7.15	7.20	10.05	7.75	6.25	4.80	6.05	5.55	4.50	4.30
29	3.90	5.55	8.75	7.05	10.35	7.75	5.95	4.75	6.15	5.45	4.50	4.20
30	3.90	.....	7.75	7.30	10.25	7.65	5.70	4.60	6.20	5.40	4.50	4.30
31	3.90	.....	7.20	.....	10.15	.....	5.65	4.55	.....	5.35	.....	4.60

NOTE.—Gage heights in parenthesis are estimated.

Rating table for King River near Sanger, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.70	130	5.00	740	6.30	1,730	8.00	3,900
3.80	165	5.10	805	6.40	1,820	8.20	4,280
3.90	200	5.20	870	6.50	1,920	8.40	4,700
4.00	240	5.30	940	6.60	2,020	8.60	5,140
4.10	280	5.40	1,010	6.70	2,120	8.80	5,600
4.20	325	5.50	1,085	6.80	2,230	9.00	6,080
4.30	370	5.60	1,160	6.90	2,340	9.50	7,460
4.40	420	5.70	1,235	7.00	2,460	10.00	9,100
4.50	470	5.80	1,310	7.20	2,700	10.50	11,150
4.60	520	5.90	1,390	7.40	2,960	11.00	13,500
4.70	570	6.00	1,470	7.60	3,240	11.50	16,300
4.80	625	6.10	1,550	7.80	3,560	12.00	19,300
4.90	680	6.20	1,640				

Estimated monthly discharge of King River near Sanger, Cal., for 1904.

[Drainage area, 1,742 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	240	130	183	11,252	0.11	0.13
February	2,340	200	618	35,548	.36	.39
March	8,080	940	2,166	133,182	1.24	1.43
April	5,960	2,175	3,549	211,180	2.04	2.28
May	15,700	2,700	10,376	637,995	5.96	6.87
June	14,550	3,320	7,563	450,030	4.34	4.84
July	3,170	1,198	1,957	120,331	1.12	1.29
August	1,870	495	1,041	64,008	.60	.69
September	3,100	280	702	41,772	.40	.45
October	3,990	975	1,901	116,888	1.09	1.26
November	975	420	620	36,893	.36	.40
December	520	302	354	21,767	.20	.23
The year	15,700	3,320	2,586	1,880,846	1.48	20.26

KING RIVER AT KINGSBURG, CAL.

This station was established in 1879 by the engineering department of the Southern Pacific Company. No meter measurements have been made since 1898, except a low-water measurement in 1902, because it was found impossible to construct a satisfactory rating table on account of the changes in gage heights, caused by the raising and lowering of the head-gate of the Peoples canal, which takes water from King River a few miles below the gaging station.

The gage heights have been furnished by William Hood, chief engineer of the Southern Pacific Railway Company. Alf. Thompson was the observer. The gage readings were discontinued March 8, 1904.

Mean daily gage height, in feet, of King River at Kingsburg, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1	2.20	2.20	4.30	17	1.70	7.00	.....
2	2.20	2.20	4.20	18	1.70	5.20	.....
3	2.20	2.20	4.00	19	2.10	4.30	.....
4	2.10	2.20	4.10	20	2.10	3.90	.....
5	2.10	2.20	4.10	21	2.20	4.10	.....
6	2.00	2.50	4.00	22	2.10	4.10	.....
7	2.00	2.80	3.90	23	2.10	4.00	.....
8	2.00	2.50	.....	24	2.00	3.80	.....
9	2.00	2.80	.....	25	2.20	4.10	.....
10	2.00	2.50	.....	26	2.20	4.10	.....
11	2.00	2.40	.....	27	2.20	4.30	.....
12	1.10	2.40	.....	28	2.20	4.90	.....
13	1.80	2.50	.....	29	2.20	5.60	.....
14	1.10	3.00	.....	30	2.20	.....	.....
15	1.80	3.00	.....	31	2.20	.....	.....
16	1.70	3.40	.....				

KAWEAH RIVER BELOW THREE RIVERS, CAL.

This station was established April 29, 1903, by W. H. Stearns. It is located at a point three-fourths of a mile below the confluence of the North, Middle, and South forks. It is 17 miles from the Southern Pacific Railway station at Exeter, Tulare County, Cal., and one-fourth of a mile west of the wagon road from Exeter to Three Rivers. The gage consists of a vertical 2-inch pipe driven 3 feet into the river bed. This is used up to medium stages. For high-water readings a timber gage is securely nailed to a willow tree on the left bank of the stream. The gage is read twice each day by Miss Mary Landsdowne. Discharge measurements are made from a cable and car. The initial point for soundings is a sycamore tree on the left bank of the stream, to which the cable is fastened. The channel is straight for 400 feet above and below the station. The current is swift at high stages, but sluggish at low water. There are rapids about 400 feet above the cable. The right bank is low and subject to overflow at high stages. The left bank is high enough to prevent overflow. There are willow trees along the water's edge on both banks and a line of willows, sycamores, and cottonwoods back from the water's edge on the left bank. The bed of the stream is composed of sand, gravel, and bowlders. Some of the bowlders are 2 feet in diameter. The section is probably permanent. The bench mark is a large rock 10 feet upstream from the tree to which the cable is attached. It is marked "B. M." in black paint. Its elevation is 13.95 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Kaweah River below Three Rivers, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
January 18	G. C. Morgan	4.50	90
January 29	do	4.40	67
February 7	C. E. Bell	4.80	113
February 21	do	5.00	225
March 11	do	5.90	465
March 20	do	6.90	1,240
March 23	do	8.40	4,788
March 28	do	6.00	695
March 29	W. B. Newhall	6.75	1,195
April 17	C. E. Bell	6.50	926
June 7	F. R. S. Buttemer	6.90	1,276
June 14	do	6.65	1,016
June 21	do	6.05	692
June 28	do	5.75	493
July 7	do	5.45	377
July 14	do	5.05	204
July 15	do	5.05	222
July 22	do	4.85	145
July 30	do	4.65	101
August 6	do	4.70	127
August 14	do	4.55	92
August 21	do	4.45	77
August 28	do	4.50	87
September 3	do	4.30	57
September 11	do	4.28	53
September 23	do	4.27	47
September 27	do	5.34	310
October 3	do	5.31	303
October 9	do	5.81	495
October 11	do	7.99	2,730
October 18	do	5.35	292
October 24	do	5.20	221
November 1	do	4.90	160
November 10	do	4.70	111
November 18	do	4.67	100
November 28	do	4.60	95
December 5	do	4.55	89
December 12	do	4.53	80

Mean daily gage height, in feet, of Kaweah River below Three Rivers, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.40	5.15	5.65	6.15	6.25	7.10	5.60	(4.65)	(4.30)	(5.30)	4.90	4.60
2	4.40	5.20	5.65	6.05	6.25	7.15	(5.60)	(4.65)	(4.30)	(5.30)	(4.90)	4.60
3	4.35	5.20	5.55	6.10	6.45	7.35	(5.60)	(4.65)	(4.30)	(5.30)	(4.90)	4.60
4	4.30	5.20	5.50	6.05	6.55	7.70	(5.50)	(4.65)	(4.30)	(5.30)	(4.90)	4.60
5	4.30	5.30	5.40	6.10	6.85	7.65	(5.50)	(4.65)	(4.30)	(5.40)	(4.80)	4.55
6	4.30	5.30	5.40	6.35	7.20	7.35	(5.50)	4.70	(4.30)	(5.50)	(4.80)	4.50
7	4.30	5.30	5.40	6.55	7.80	7.15	5.45	(5.00)	(4.30)	(5.60)	(4.80)	4.50
8	4.30	5.30	5.40	6.70	7.80	6.95	(5.40)	(5.20)	(4.30)	(5.70)	(4.80)	4.55
9	4.30	5.30	5.30	6.80	7.85	6.75	(5.30)	(5.40)	(4.30)	(5.80)	(4.80)	4.50
10	4.30	5.30	5.30	6.90	7.85	6.75	(5.30)	(5.20)	(4.30)	(5.80)	(4.75)	4.60
11	4.30	5.40	5.40	6.95	8.00	7.30	(5.20)	(4.80)	(4.30)	(8.00)	(4.70)	4.55
12	4.40	5.40	5.80	7.00	7.95	7.30	(5.20)	(4.55)	(4.30)	(7.90)	(4.70)	4.55
13	4.40	5.40	5.90	7.05	8.05	6.80	(5.10)	(4.55)	(4.30)	(7.00)	(4.70)	4.50
14	4.40	5.20	5.80	6.60	8.05	6.55	5.05	4.55	(4.30)	(6.50)	(4.70)	4.50
15	4.40	5.40	5.80	6.75	8.05	6.35	5.05	(4.55)	(4.30)	(6.00)	(4.70)	4.50
16	4.40	7.80	5.70	6.85	8.05	6.45	(5.00)	(4.55)	(4.30)	(5.50)	(4.70)	4.50
17	4.40	7.35	5.65	6.50	8.10	6.50	(5.00)	(4.50)	(4.30)	(5.50)	(4.70)	4.55
18	4.50	7.30	5.80	6.50	7.90	6.40	(5.00)	(4.50)	(4.25)	(5.35)	(4.65)	4.50
19	4.50	7.20	6.10	7.50	7.65	6.20	(4.90)	(4.50)	(4.25)	(5.30)	(4.65)	4.55
20	4.50	7.20	6.20	6.75	7.70	6.10	(4.90)	(4.45)	(4.25)	(5.30)	4.65	4.50
21	4.50	7.20	6.00	6.35	7.60	6.05	(4.90)	4.45	4.25	(5.30)	4.65	4.40
22	4.50	6.80	6.00	6.35	7.55	(6.00)	4.85	(4.45)	(4.25)	(5.30)	4.60	4.50
23	4.50	6.70	8.40	6.15	7.75	(6.00)	(4.80)	(4.45)	(4.25)	(5.20)	4.60	4.50
24	4.55	6.65	6.10	6.15	7.90	(5.90)	(4.80)	(4.45)	(4.25)	5.20	4.60	4.60
25	4.60	6.40	6.00	6.40	7.90	(5.90)	(4.80)	(4.50)	(6.00)	(5.20)	4.60	4.85
26	4.60	6.30	6.10	6.45	7.65	(5.80)	(4.70)	(4.50)	(8.00)	(5.20)	4.60	4.60
27	4.60	5.90	5.90	6.50	7.40	(5.80)	(4.70)	(4.50)	5.35	(5.10)	4.60	4.65
28	4.70	5.80	6.25	6.40	7.10	5.75	(4.70)	(4.50)	(5.35)	(5.10)	4.60	4.55
29	4.70	5.70	7.15	6.30	7.15	(5.70)	(4.70)	(4.40)	(5.30)	(5.00)	4.60	4.60
30	4.70	.....	6.75	6.40	7.05	(5.70)	4.65	(4.40)	(5.30)	(5.00)	4.60	4.60
31	5.05	.....	6.15	.....	7.10	.....	(4.65)	(4.40)	.....	(4.90)	.....	5.30

From June 21 to November 28, inclusive, gage heights interpolated between those of meter measurements.

Rating table for Kaweah River below Three Rivers, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
4.20	40	5.30	280	6.40	850	7.50	1,950
4.30	53	5.40	315	6.50	920	7.60	2,080
4.40	66	5.50	350	6.60	1,000	7.70	2,220
4.50	80	5.60	390	6.70	1,080	7.80	2,380
4.60	95	5.70	435	6.80	1,170	7.90	2,550
4.70	115	5.80	485	6.90	1,260	8.00	2,730
4.80	135	5.90	540	7.00	1,360	8.10	2,920
4.90	160	6.00	600	7.10	1,470	8.20	3,120
5.00	190	6.10	660	7.20	1,580	8.30	3,370
5.10	220	6.20	720	7.30	1,700	8.40	3,700
5.20	250	6.30	780	7.40	1,820		

Estimated monthly discharge of Kaweah River below Three Rivers, Cal., for 1904.

[Drainage area, 520 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	205	53	78	4,796	0.15	0.17
February	2,380	235	729	41,933	1.40	1.50
March	1,525	280	640	39,352	1.23	1.42
April	1,415	630	968	57,600	1.86	2.08
May	2,920	750	2,054	126,296	3.95	4.55
June	2,220	435	1,052	62,598	2.02	2.25
July	390	105	220	13,527	.42	.48
August	315	60	108	6,641	.21	.24
September	2,730	46	190	11,306	.37	.41
October	2,730	160	511	31,420	.98	1.13
November	160	95	117	6,962	.22	.25
December	280	66	95	5,841	.18	.21
The year	2,920	46	564	408,272	1.08	14.69

TULE RIVER NEAR PORTERSVILLE, CAL.

The gaging station is located about 8 miles east of Portersville at a point just below the wagon bridge near McFarland ranch and about 1 mile above the mouth of South Fork of Tule River. The station was established April 8, 1901. The gage rod is situated on the right bank of the river 100 feet below the bridge. The bench mark is a cross on the top of a large bowlder on the right bank of the river between the cable and the bridge and is 13.10 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Tule River near Portersville, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
February 1	F. W. Huber	1.28	36
April 1	W. B. Newhall	2.86	342
July 2	F. R. S. Buttemer	1.25	30
July 20	do	1.00	16
July 28	do	.90	10.2
August 17	do	.85	7.9
September 9	do	.76	6.9
October 6	do	1.24	30
October 30	do	1.25	31
November 15	do	1.20	26
November 29	do	1.18	25
December 15	do	1.25	27

Mean daily gage height, in feet, of Tule River near Portersville, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.20	1.20	1.90	2.90	2.50	2.10	1.20	0.85	0.85	1.20	1.25	1.20
2	1.20	1.20	1.90	2.80	2.60	2.05	1.15	.85	.80	1.20	1.30	1.20
3	1.20	1.20	1.85	2.70	2.60	2.00	1.15	.85	.80	1.20	1.30	1.20
4	1.20	1.20	1.85	2.70	2.60	2.00	1.20	.85	.80	1.20	1.30	1.20
5	1.20	2.00	1.85	2.75	2.70	2.00	1.20	.90	.80	1.20	1.30	1.20
6	1.20	1.80	1.70	2.80	2.80	1.95	1.15	.90	.80	2.00	1.30	1.20
7	1.20	1.60	1.70	2.80	2.80	1.90	1.15	.90	.80	1.60	1.30	1.20
8	1.20	1.40	1.60	2.65	2.80	1.85	1.15	.90	.80	1.40	1.25	1.20
9	1.20	1.35	1.60	2.45	2.80	1.80	1.15	.90	.80	1.80	1.25	1.25
10	1.20	1.35	1.60	2.60	2.85	1.75	1.10	.85	.80	1.50	1.25	1.25
11	1.20	1.35	2.35	2.80	2.85	1.75	1.10	.85	.80	1.70	1.20	1.25
12	1.20	1.35	2.00	2.75	2.90	1.70	1.10	.85	.80	2.30	1.20	1.25
13	1.20	1.80	1.90	2.75	2.90	1.65	1.05	.85	.80	1.80	1.20	1.25
14	1.20	1.60	1.85	2.75	2.90	1.60	1.05	.85	.80	1.70	1.20	1.25
15	1.20	1.45	1.90	2.70	2.85	1.55	1.05	.85	.80	1.60	1.20	1.25
16	1.15	4.10	2.00	2.60	2.80	1.50	1.05	.85	.80	1.55	1.20	1.25
17	1.15	3.10	2.00	2.50	2.75	1.45	1.00	.85	.80	1.50	1.20	1.25
18	1.40	2.10	2.10	2.40	2.65	1.40	1.00	.85	.85	1.45	1.20	1.25
19	1.30	1.90	2.10	3.15	2.60	1.40	1.00	.80	.85	1.40	1.20	1.25
20	1.30	1.85	3.00	2.90	2.55	1.40	1.00	.80	.90	1.35	1.20	1.25
21	1.30	1.80	2.90	2.70	2.50	1.40	.95	.80	.90	1.35	1.20	1.30
22	1.30	1.75	2.40	2.60	2.45	1.40	.95	.80	.95	1.30	1.20	1.30
23	1.30	1.70	6.15	2.50	2.40	1.35	.95	.85	.95	1.30	1.20	1.35
24	1.25	1.65	3.20	2.40	2.40	1.35	.95	.85	1.00	1.30	1.20	1.40
25	1.25	1.65	2.70	2.40	2.35	1.30	.90	.90	2.10	1.30	1.20	1.65
26	1.25	1.60	2.50	2.70	2.30	1.30	.90	.90	1.70	1.30	1.20	1.45
27	1.20	1.60	2.40	2.60	2.30	1.25	.90	.90	1.55	1.25	1.20	1.40
28	1.20	2.70	3.20	2.55	2.30	1.25	.90	.95	1.40	1.25	1.20	1.35
29	1.20	2.00	3.80	2.55	2.25	1.20	.85	.95	1.30	1.25	1.20	1.35
30	1.20	.....	3.70	2.50	2.20	1.20	.85	.90	1.25	1.25	1.20	1.30
31	1.20	.....	3.30	.....	2.10	.....	.85	.85	.....	1.25	.....	1.70

Rating table for Tule River near Portersville, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.80	7	2.00	132	3.20	450	4.60	1,180
.90	10	2.10	150	3.30	490	4.80	1,300
1.00	15	2.20	170	3.40	530	5.00	1,420
1.10	21	2.30	190	3.50	575	5.20	1,560
1.20	28	2.40	210	3.60	625	5.40	1,700
1.30	37	2.50	235	3.70	675	5.60	1,850
1.40	47	2.60	260	3.80	725	5.80	2,010
1.50	58	2.70	285	3.90	775	6.00	2,170
1.60	70	2.80	315	4.00	830	6.50	2,620
1.70	83	2.90	345	4.20	940	7.00	3,120
1.80	98	3.00	380	4.40	1,060	7.50	3,670
1.90	115	3.10	415				

Estimated monthly discharge of Tule River near Portersville, Cal., for 1904.

[Drainage area, 437 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	47	28	30	1,845	0.07	0.08
February	885	28	121	6,960	.28	.30
March	2,305	70	283	17,401	.65	.75
April	432	210	279	16,602	.64	.71
May	345	150	262	16,110	.60	.69
June	150	28	74	4,403	.17	.19
July	28	8	17	1,045	.04	.05
August	12	7	9	553	.02	.02
September	150	7	20	1,190	.05	.06
October	190	28	55	3,382	.13	.15
November	37	28	30	1,785	.07	.08
December	83	28	37	2,275	.08	.09
The year	2,305	7	101	73,551	.23	3.17

KERN RIVER NEAR BAKERSFIELD, CAL.

This station, established in 1893 by Walter James, chief engineer of the Kern County Land Company, is located at what is known as "first point of measurement," 5 miles above Bakersfield and at the mouth of the canyon of the river. Regular meter measurements are taken, and an automatic gage records daily fluctuations of the river heights. A. K. Warren, the engineer in charge of this work for the Kern County Land Company, attends to the discharge measurements with accuracy and precision, and furnishes the Geological Survey with the final results.

Mean daily discharge, in second-feet, of Kern River near Bakersfield, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	193	203	451	1,182	875	2,130	915	553	327	415	317	263
2	188	206	396	1,050	856	2,173	918	607	329	421	316	265
3	181	214	394	956	825	2,526	977	547	304	420	326	260
4	176	219	380	951	852	2,941	895	493	275	421	335	255
5	186	220	406	926	861	2,814	854	470	260	431	330	269
6	188	243	433	935	952	2,578	809	500	242	466	322	246
7	196	238	431	984	1,140	2,452	760	497	227	506	319	228
8	183	233	413	1,022	1,341	2,139	772	559	229	561	297	211
9	184	242	403	1,048	1,488	1,859	766	567	218	568	291	221
10	190	232	414	1,048	1,548	1,786	737	594	214	595	285	231
11	191	222	410	1,106	1,645	1,832	689	556	209	569	277	232
12	199	226	455	1,133	1,820	1,896	668	504	207	575	274	230
13	198	247	399	1,175	2,036	1,909	658	459	201	602	272	230
14	200	256	446	1,203	2,216	1,854	624	432	194	551	274	240
15	195	287	445	1,177	2,324	1,763	564	477	195	528	279	240
16	194	274	494	1,177	2,411	1,764	541	516	242	498	276	234
17	209	821	537	1,079	2,467	1,766	525	500	246	490	277	228
18	219	743	523	1,019	2,616	1,717	504	516	239	433	270	225
19	198	512	527	1,012	2,563	1,573	510	450	248	394	271	225
20	181	421	674	1,107	2,188	1,426	510	419	245	378	266	225
21	165	377	1,000	1,017	1,961	1,410	487	396	218	369	274	213
22	158	363	777	962	1,857	1,269	476	363	200	356	275	224
23	173	388	872	934	1,846	1,230	494	328	210	349	275	234
24	204	407	1,085	838	2,211	1,258	516	339	199	337	280	243
25	231	427	842	814	2,627	1,252	566	329	211	349	273	249
26	229	386	720	868	2,737	1,128	590	380	352	353	263	262
27	225	392	739	884	2,441	1,070	587	384	498	358	271	239
28	218	439	861	852	2,107	1,025	571	490	457	345	260	237
29	207	598	1,574	846	2,035	945	542	480	415	325	266	266
30	190	.....	1,759	849	2,111	899	520	413	405	314	268	255
31	193	.....	1,408	.....	2,118	.....	483	366	.....	313	.....	295

Estimated monthly discharge of Kern River near Bakersfield, Cal., for 1904.

[Drainage area, 2,345 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	241	156	195	11,990	0.08	0.09
February	1,403	199	346	19,902	.15	.16
March	2,456	351	667	41,012	.28	.32
April	1,295	796	1,005	59,802	.43	.48
May	2,932	810	1,841	113,199	.79	.91
June	3,167	868	1,746	103,894	.74	.83
July	992	441	646	39,721	.28	.32
August	652	310	467	28,715	.20	.23
September	524	187	267	15,888	.11	.12
October	666	303	438	26,932	.19	.22
November	342	249	286	17,018	.12	.13
December	350	208	241	14,819	.10	.12
The year	3,167	156	679	492,892	.29	3.93

STATIONS IN YOSEMITE VALLEY, CALIFORNIA.

During the summer of 1904 the commissioners of Yosemite Valley were desirous of having discharge stations established on several of the principal streams in the Yosemite Valley. The hydrographic branch of the Geological Survey agreed to establish these stations, furnish the necessary instruments for making the discharge measurements, make all office computations, and compile the records, the commissioners to furnish the assistant to do the field work. Stations were established June 9–11, 1904, on the Merced River at the bridge near the Sentinel Hotel; on the Yosemite Creek at bridge between Yosemite post-office and Yosemite Falls, and on Tenaya Creek at bridge between Yosemite post-office and Mirror Lake. The commissioners detailed Mr. N. W. Currie to take charge of the field work, which consisted of making weekly discharge measurements and reading the gages daily. Mr. Currie made one discharge measurement at each of the stations after they were installed and kept daily gage readings to September 24, 1904. He then stopped the work entirely, but failed to notify the hydrographer in charge until December 20, when he was asked to send his records to the hydrographer for compilation. Mr. Currie then stated that this extra work was put upon him in connection with his duties as electrician; and as he received no compensation for it, he discontinued the work upon the advice and consent of the

guardian of the park. It was hoped that a sufficient number of measurements would have been made during the past summer to have rated these streams, so that by keeping a continuous gage record the daily discharge could be published weekly in the daily papers throughout the State as a matter of interest to parties who desire to visit the valley at a time when the streams are discharging in considerable volume and when the several falls are seen to the best advantage. These measurements will be continued another summer.

MERCED RIVER NEAR SENTINEL HOTEL, YOSEMITE VALLEY, CALIFORNIA.

This station was established July 11, 1904, by E. A. Chandler and N. W. Currie. It is located at the wagon bridge near the Sentinel Hotel. The gage is a 1 by 6 inch vertical timber, painted white, and graduated to feet and tenths. It is securely fastened to a masonry abutment on west bank. Discharge measurements are made from lower side of bridge. The distance across the stream is marked by nails in the floor of the bridge every 5 feet. The initial point for soundings is stream face of abutment on right bank. The channel is straight for a distance of 150 feet above and 50 feet below station. The current is sluggish. The right bank is low and subject to overflow. The left bank is high and above high water. The bed of the stream is composed of coarse gravel and sand, with small bowlders, and is not subject to much change. The bench mark is heads of two large nails driven into stream face of bridge-seat timber on the left abutment. Its elevation is 14.64 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Merced River near Sentinel Hotel, Yosemite Valley, California, in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
July 11	A. E. Chandler	4.60	555
July 18	N. W. Currie	4.39	431

Mean daily gage height, in feet, of Merced River near Sentinel Hotel, Yosemite Valley, California, in 1904.

Day.	July.	Aug.	Sept.	Day.	July.	Aug.	Sept.
1		4.20	3.45	17	4.30	4.00	3.60
2		4.45	3.40	18	4.40	3.90	3.60
3		4.10	3.40	19	4.50	3.75	3.50
4		4.10	3.40	20	4.50	3.75	3.45
5		4.40	3.35	21	4.48	3.70	3.40
6		4.60	3.35	22	4.70	3.60	3.40
7		4.30	4.30	23	4.60	3.55	3.50
8		4.10	4.30	24	4.48	3.55	4.20
9		4.00	3.30	25	4.40	3.50	
10		3.90	3.30	26	4.40	3.50	
11	4.60	3.90	3.30	27	4.35	3.55	
12	4.70	3.80	3.30	28	4.25	3.60	
13	4.57	3.75	3.30	29	4.10	3.55	
14	4.50	3.80	3.30	30	4.00	3.50	
15	4.40	4.15	3.35	31	4.00	3.48	
16	4.30	4.05	3.60				

TENAYA CREEK AT YOSEMITE VALLEY, CALIFORNIA.

This station was established July 11, 1904, by A. E. Chandler and N. W. Currie. It is located by the wagon bridge about 2 miles from Yosemite, Cal. The gage is a 1 by 6 inch vertical timber, painted white, and graduated to feet and tenths. It is securely fastened to the bridge stringer on upper side of bridge 9 feet from left abutment. Discharge measurements are made from the bridge. The distance across the stream is marked by nails in the bridge stringer every 5 feet. The initial point for soundings is the stream face of the abutment on the right bank. The channel is straight for 200 feet above and 200 feet below the station. Both banks are above high water. The bed of the stream is composed of small granite fragments and is not subject to change. The bench mark is formed by the heads of two nails in the top of the bridge stringer near the gage. Its elevation is 12.70 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Tenaya Creek at Yosemite Valley, California, in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
July 11	N. W. Currie	4.42	85
July 19	do	4.00	45

Mean daily gage height, in feet, of Tenaya Creek at Yosemite Valley, California, in 1904.

Day.	July.	Aug.	Sept.	Day.	July.	Aug.	Sept.
1	.....	3.80	3.40	17	4.08	3.70	3.40
2	.....	3.85	3.40	18	4.02	3.60	3.40
3	.....	3.70	3.40	19	4.00	3.55	3.40
4	.....	3.90	3.40	20	4.00	3.50	3.40
5	.....	3.75	3.40	21	4.00	3.50	3.40
6	.....	3.70	3.40	22	4.00	3.50	3.40
7	.....	3.70	3.40	23	3.90	3.50	.....
8	.....	3.60	3.40	24	3.90	3.50	4.40
9	.....	3.60	3.38	25	3.90	3.50	.....
10	.....	3.60	3.38	26	3.85	3.45	.....
11	4.40	3.60	3.40	27	3.80	3.45	.....
12	4.40	3.50	3.40	28	3.80	3.45	.....
13	4.30	3.50	3.40	29	3.75	3.40	.....
14	4.20	3.50	3.40	30	3.70	3.40	.....
15	4.20	3.80	3.40	31	3.70	3.40	.....
16	4.10	3.80	3.40				

YOSEMITE CREEK AT YOSEMITE VALLEY, CALIFORNIA.

This station was established July 9, 1904, by A. E. Chandler and N. W. Currie. It is located at the wagon bridge about one-half mile from Yosemite, Cal. The gage is a 1 by 6 inch vertical timber, painted white, and graduated to feet and tenths. It is securely fastened to an alder tree on the right bank 50 feet above bridge. Discharge measurements are made from lower side of bridge. The distance across the stream is marked by nails in bridge stringer every 5 feet. The initial point for soundings is stream face of abutment on right bank. The channel is straight for 50 feet above and 100 feet below station; both banks are above high water. The bed of the stream is composed of small granite fragments and is permanent. The bench mark is head of two nails driven in an alder tree, to which gage is fastened. Its elevation is 9.40 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Yosemite Creek at Yosemite Valley, California, in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
July 9	A. E. Chandler	4.85	70
July 19	N. W. Currie	4.49	33

Mean daily gage height, in feet, of Yosemite Creek at Yosemite Valley, California, for 1904.

Day.	July.	Aug.	Sept.	Day.	July.	Aug.	Sept.
1	.....	4.30	3.80	17	4.40	3.90	3.75
2	.....	4.70	3.80	18	4.40	3.90	3.80
3	.....	4.30	3.80	19	4.50	3.90	3.75
4	.....	4.30	3.80	20	4.45	3.90	3.75
5	.....	4.15	3.75	21	4.40	3.85	3.75
6	.....	4.18	3.75	22	4.40	3.80	3.75
7	.....	.....	3.75	23	4.38	3.85	3.85
8	.....	4.00	3.75	24	4.38	3.84	4.60
9	.....	4.00	3.75	25	4.30	3.85	.....
10	.....	3.95	3.75	26	4.20	3.80	.....
11	4.60	3.90	3.75	27	4.05	3.80	.....
12	4.70	3.90	3.75	28	4.10	3.80	.....
13	4.70	3.90	3.75	29	4.00	3.80	.....
14	4.55	3.90	3.75	30	4.00	3.80	.....
15	4.50	4.00	3.75	31	4.00	3.80	.....
16	4.50	4.05	3.80				

MISCELLANEOUS MEASUREMENTS IN SAN FRANCISCO BAY DRAINAGE BASIN.

The following miscellaneous measurements were made in the San Francisco Bay drainage basin in 1903 and 1904:

Miscellaneous measurements in San Francisco Bay drainage basin.

ALAMEDA CREEK DRAINAGE.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1904.				*Sec.-feet.*
May 27	S. G. Bennett	Arroyo Hondo	Near Sunol	18
May 27	do	Alameda Creek	At Niles dam	25

SACRAMENTO RIVER DRAINAGE.

1904.				
Aug. 9	W. B. Clapp	Upper Sacramento River.	Bards Station, Shasta County.	429
Aug. 11	do	Battle Creek	Near Balls Ferry, Tehama County.	423
Aug. 12	do	Stanford canal	Headworks near Vina, Cal.	58

Miscellaneous measurements in San Francisco Bay drainage basin—Continued.

SACRAMENTO RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1904.				*Sec-feet.*
Aug. 12	W. B. Clapp	Deer Creek	Near Vina, below heading of Stanford Canal.	69
		Total Deer Creek		127
Aug. 12	do	Mill Creek	Near Tehama, above all diversions.	160
Aug. 13	do	Antelope Creek	Near Red Bluff, above all diversions.	53

PIT RIVER DRAINAGE.

1904.				
Apr. 5	J. S. Evans	Ash Creek	Ash Valley	194
May 5	do	do	do	189
June 4	do	do	do	30
June 10	S. G. Bennett and J. S. Evans.	do	do	27
Sept. 17	J. Y. Toler	Dukes ditch	Near Likely	3.3
Sept. 23	do	do	do	8.7
Sept. 17	do	Corporation ditch	do	30
Aug. 16	S. G. Bennett and J. Y. Toler.	Davis Creek	Near Davis Creek P. O.	2.4
Jan. 7	J. S. Evans	Pit River	At county bridge, Alturas.	81
Aug. 27	J. Y. Toler	E. Lauer's ditch	Near Alturas	1.4
Aug. 27	do	M. Hugh's ditch	do	3
June 12	S. G. Bennett and J. S. Evans.	Rush Creek	At Round Valley	12
Aug. 30	J. Y. Toler	do	do	7.6
Aug. 26	do	Pine Creek	Near Pine Creek P. O.	7
Sept. 5	do	do	do	22
Sept. 14	do	Canyon Creek	Near Centerville	3.8
Sept. 15	do	Fitzhugh Creek	Near Alturas	2.7
Aug. 29	do	Willow Creek	Near Adin	5.6
Sept. 20	do	do	do	5
1903.				
Sept. 11	H. G. Heisler	Pit River	At Pitville	30

Miscellaneous measurements in San Francisco Bay drainage basin—Continued.

PIT RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Sec.-feet.*
Sept. 11	H. G. Heisler	Fall River	At bridge near Fall-river Mills.	1,510
Sept. 10	do	Hat Creek	At Carbon Bridge	657
Sept. 9	do	Pit River	At Peck's bridge, above mouth of Burney Creek.	2,617
Sept. 9	do	Burney Creek	Below Burney Falls	210
Sept. 8	do	Hatchet Creek	Near Montgomery	10
Sept. 7	do	Montgomery Creek	At Montgomery	18

AMERICAN RIVER DRAINAGE.

1904.				
Jan. 6	S. G. Bennett	North Fork ditch	2½ miles above Folsom	32
1903.				
May 12	S. G. Bennett	Folsom canal	500 feet below heading	1,466
1904.				
Sept. 12	W. B. Clapp	South Fork	At Morman Island bridge, 4 miles above Folsom.	82
Sept. 14	do	North Fork	500 feet above junction with Middle Fork, near Auburn.	69
Sept. 14	do	Middle Fork	½ mile above Auburn bridge.	130

STANISLAUS RIVER DRAINAGE.

1903.				
Nov. 25	S. G. Bennett	Stanislaus Water Co.'s ditch.	Above penstock to power house, Knights Ferry.	85
Sept. 23	do	do	100 feet below penstock to power house, Knights Ferry.	61
Nov. 25	do	do	do	41
1904.				
Aug. 24	O. W. Peterson	Schell ditch	Near head, Knights Ferry.	7.4

Miscellaneous measurements in San Francisco Bay drainage basin—Continued.

TUOLUMNE RIVER DRAINAGE.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Sec.-feet.*
Sept. 20	S. G. Bennett	Clavey River	Above mouth of Twomile Creek, Carter-Lake Eleanor trail.	2.6
Sept. 20	do	Twomile Creek	At mouth	.8
Sept. 20	do	Hull Creek	At Carter-Lake Eleanor trail crossing.	3.7
Sept. 21	do	North Fork of Tuolumne River.	Above mouth of Basin Slope Creek.	2.9
Sept. 19	do	Reed Creek	At Roeasco ranch	2.6
Sept. 19	do	Cherry River	Carter-Lake Eleanor trail crossing.	[a] .6
Sept. 19	do	Eleanor Creek	One-half mile below Lake Eleanor.	1.0
Sept. 18	do	Tuolumne River	Above mouth, Hetch Hetchy Valley.	19.0
Sept. 18	do	Rancheria Creek	At mouth, Hetch Hetchy Valley.	1.3
Sept. 17	do	Tiltill Creek	Hetch Hetchy Valley	.2
Sept. 18	do	Tuolumne River	Lower end of Hetch Hetchy Valley.	23
Sept. 17	do	Middle Fork of Tuolumne River.	Six miles from Sequoia post-office.	.8
Sept. 17	do	South Fork of Tuolumne River.	One mile above Sequoia post-office.	7.7
1904.				
June 8	O. W. Peterson	Mining ditch	Near Lagrange dam	8.5
Aug. 22	do	do	do	3.7

MERCED RIVER DRAINAGE.

1903.				
June 25	S. G. Bennett	Tenaya Creek	At Tassaack Avenue Bridge, Yosemite Valley.	159
Sept. 15	do	do	do	3.0
June 25	do	Illilouette Creek	Near mouth of Yosemite Valley.	228
Sept. 15	do	do	do	3.9
June 24	do	Merced River	At bridge near Yosemite Valley post-office.	1,135
Sept. 15	do	do	do	27
June 24	do	Yosemite Creek	At wagon bridge below falls.	119

[a] Estimated.

Miscellaneous measurements in San Francisco Bay drainage basin—Continued.

MERCED RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Sec.-feet.*
Sept. 15	S. G. Bennett..	Yosemite Creek.....	At wagon bridge below falls.	[a] 2
June 25	.....do.....	Bridal Veil Creek....	At Yosemite road bridge.	[a] 20
Sept. 15	.....do.....	.....do.....	.....do.....	[a] 2
Sept. 13	.....do.....	Alder Creek.....	South Fork Merced...	1.0
Sept. 12	.....do.....	South Fork Merced River.	1,000 feet below Wawona Bridge.	1.5
Sept. 12	.....do.....	Washburn ditch.....	South Fork Merced...	1.9
Sept. 11	.....do.....	Big Creek.....	At Summerdale.....	3.2
Sept. 11	.....do.....	Sugar Pine ditch.....	South Fork Merced...	2.3

SAN JOAQUIN RIVER DRAINAGE.

1903.				
Sept. 11	S. G. Bennett..	Soqual ditch.....	At site of old mill of Madera Flume and Trading Co.	[b] 3.8
Sept. 9	.....do.....	Chiquita San Joaquin.	At mouth.....	10
Sept. 9	.....do.....	San Joaquin River...	Below mouth Chiquita San Joaquin.	264

KING RIVER DRAINAGE.

1903.				
Sept. 3	S. G. Bennett..	King River.....	One-half mile below mouth of North Fork.	332
Sept. 3	.....do.....	North Fork of King River.	At mouth.....	32
1904.				
May 13	S. G. Bennett and I. Teilman.	Gould canal.....	At Holland flume, ½ mile below head-gate.	260
May 13	S. G. Bennett..	Church ditch.....	Near Kingriver post-office.	1,040
May 13	S. G. Bennett and I. Teilman.	Fowler Switch canal..	200 feet below road bridge, near Kingriver post-office.	476
May 14	S. G. Bennett..	.....do.....	.....do.....	588
May 13	.....do.....	Centerville and Kingsburg canal.	200 feet below Trimmer Spring road bridge, near Kingriver post-office.	727

[a] Estimated.
[b] Total flow of North Fork of San Joaquin River at this point.

Miscellaneous measurements in San Francisco Bay drainage basin—Continued.

KING RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Sec.-feet.*
May 14	S. G. Bennett..	'76 canal	At bridge near Carmelita.	676
May 17	.....do	Peoples ditch	300 feet below headgate near Kingsburg.	483
May 14	S. G. Bennett and I. Teilman.	Emigrant ditch	Near headworks, 3 miles from Kingsburg.	114
May 17	S. G. Bennett..	Last Chance ditch....	Near Laton.....	297
May 17	.....do	La Gunada de Tacahe grant canal.	At Laton.....	227
May 16	.....do	Liberty canal	At Lemoore road bridge crossing.	55
May 17	.....do	Lower King River canal.	Near Grangeville	180
May 16	.....do	Heinlen cut.....	50 feet above regulating weir.	1,298
May 16	S. G. Bennett and I. Teilman.	Zelda canal slough...	1,500 feet below Lemoore road.	5,420
May 20	S. G. Bennett ..	Mill race ditch.....	Near head.....	20
May 19	.....do	Riverdale canal	.....do.....	[a] 1
May 19	.....do	Burrell ditch.....	.....do.....	42
May 19	.....do	Waste from New Riverdale ditch.	Into lower King River.	45
		Total New Riverdale canal.	Above waste	88
May 19	.....do	Turner ditch.....	Near head.....	8
May 19	.....do	Reed ditch	.....do.....	28
May 19	.....do	Crescent canal	Near Wheatville.....	38
May 19	.....do	Stimson canal.....	At Elkhorn road bridge crossing.	175

KAWEAH RIVER DRAINAGE.

1903.				
Aug. 31	S. G. Bennett ..	Stony Creek	North Fork Kaweah trail crossing.	1.2
Aug. 31	.....do	Dorst Creek.....	At North Fork Kaweah trail crossing.	2.6
Aug. 28	.....do	North Fork Kaweah..	3 miles above Three Rivers.	7.3
1904.				
Sept. 20	F. R. S. Buttemer.	North Fork Kaweah River.	300 feet above intake of Schreibers ditch.	6.0

[a] Waste; water shut off.

Miscellaneous measurements in San Francisco Bay drainage basin—Continued.

KAWEAH RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Sec.-feet.*
Aug. 30	S. G. Bennett ..	Marble Fork Kaweah River.	At bridge, Sequoia Park.	8.7
1904.				
Sept. 19	F. R. S. Buttemer.	Marble Fork Keweah River.	At bridge, Sequoia Park.	4.7
1903.				
Aug. 26	S. G. Bennett ..	East Fork Kaweah River.	At Mineral King.....	5.3
Aug. 26	.....do	.....do	Above headworks of Mount Whitney Power Co.'s canal.	23
1904.				
Sept. 16	F. R. S. Buttemer.	East Fork Kaweah River.	Above headworks of Mount Whitney Power Co.'s canal.	34
Sept. 22	.....do	Middle Fork Kaweah River.	800 feet above intake, Mount Whitney Power Co.'s canal.	27
Sept. 15	.....do	South Fork Kaweah River.	Above intake Cahoon's ditch, 9½ miles above junction with Middle Fork.	7.1
Sept. 18	.....do	Middle Fork Kaweah River.	200 feet above junction with Marble Fork.	23

TULE RIVER DRAINAGE.

1903.				
June 9	R. S. Hawley...	South Fork Tule River.	Near mouth.....	35
1904.				
Feb. 2	F. W. Huber...	South Fork Tule River.	Near mouth.....	7

KERN RIVER DRAINAGE.

1903.				
Aug. 24	S. G. Bennett ..	Little Kern River	3 miles below mouth of Shotgun Creek.	5.3
Aug. 22	.....do	.....do	Above junction with Kern River.	25
Aug. 22	.....do	North Fork Kern River.	Above junction with Little Kern River.	278
Aug. 21	.....do	Soda Creek	3 miles above mouth..	2.4
Aug. 21	.....do	Nameless Creek.....	.....	2.4
Aug. 20	.....do	Clark Creek	.....	2.9

Miscellaneous measurements in San Francisco Bay drainage basin—Continued.

KERN RIVER DRAINAGE—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Sec.-feet.*
Aug. 20	S. G. Bennett	Jackson Creek		2.8
Aug. 20	do	Wade Creek		2.6
Aug. 19	do	Tobias Creek	At mouth	1.9
Aug. 19	do	Salmon Creek	do	1.8
Aug. 18	do	Bull Run Creek	Above mouth	.8
Aug. 17	do	Peterson ditch	Near head, above Kernville.	1.5
Aug. 17	do	Thurston ditch	do	1.9
Aug. 17	do	North Fork of Kern River.	3 miles above Kernville.	277
Aug. 17	do	Big Blue ditch	At mill above Kernville.	25
Aug. 17	do	Neal & Stavert's upper ditch.	Above Kernville	2.2
Aug. 15	do	Brown's upper ditch		15.3
Aug. 15	do	Brown's ranch ditch		14.5
Aug. 15	do	Kernville town ditch		0.7
Aug. 15	do	Cook's ditch	Kernville	0.6
Aug. 17	do	Hooper Mill ditch	Near Isabella	8.9
Aug. 17	do	South Fork of Kern River.	Above mouth near Isabella.	17
Aug. 17	do	Kern River	Below mouth of South Fork, near Isabella.	254

NORTHERN PACIFIC OCEAN DRAINAGE BASIN.

LOST RIVER AT CLEAR LAKE, CAL.

Discharge measurements of Lost River at Clear Lake, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
September 7	T. H. Humphreys	4.95	10.78
September 25	C. T. Darley	5.20	16.00
October 21	F. S. Chapman	5.15	14.00
November 6	C. T. Darley	5.15	17.60
December 9	do	5.18	14.00

Mean daily gage height, in feet, of Lost River at Clear Lake, Cal., for 1904.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1	.....	5.25	5.20	5.20	17	5.00	5.25	5.20	.....
2	.....	5.25	5.20	5.20	18	5.00	5.25	5.20	.....
3	.....	5.25	5.15	.....	19	5.00	5.20	.....	.....
4	5.00	5.25	5.10	.....	20	5.00	5.20	.....	5.30
5	5.00	5.25	.....	.....	21	5.00	5.15	.....	5.15
6	5.00	5.25	.....	5.20	22	5.05	5.15	.....	5.20
7	5.00	5.25	.....	5.20	23	5.10	.....	5.20	5.20
8	5.00	5.25	5.15	5.15	24	5.10	.....	5.20	.....
9	5.00	5.25	5.15	5.15	25	5.20	5.10	5.20	.....
10	5.00	5.30	5.15	.....	26	5.25	5.10	5.20	.....
11	5.00	5.30	5.15	.....	27	5.25	5.10	.....	.....
12	5.00	5.30	.....	.....	28	5.25	5.10	5.20	.....
13	5.00	5.30	.....	5.20	29	5.25	.....	5.20	.....
14	5.00	5.30	.....	5.25	30	5.25	.....	.....	.....
15	5.00	5.30	5.15	5.30	31	.....	.....	.....	.....
16	5.00	5.30	5.20	5.30					

MILLER CREEK NEAR LORELLA, OREG.

Discharge measurements of Miller Creek at Horsefly, near Lorella, Oreg., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
June 24	T. H. Humphreys	.....	[a] 15.00
July 7	do	.....	[a] 12.00
August 4	do	.....	[a] 5.00
August 23	do	.....	[a] 1.00
September 27	do	6.10	1.71
October 16	C. T. Darley	6.20	4.09
November 19	do	6.25	7.26

[a] Estimated.

Mean daily gage height, in feet, of Miller Creek at Horsefly, near Lorella, Oreg., for 1904.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	6.00	6.10	6.10	6.20	17	6.10	.....	6.20	6.10	.....
2	.....	6.00	6.10	6.20	6.20	18	6.10	.....	6.20	6.30	.....
3	.....	6.00	6.10	6.20	6.15	19	6.10	.....	6.10	6.20	.....
4	.....	6.00	6.10	6.20	6.10	20	6.10	.....	6.10	6.20	.....
5	.....	6.00	6.10	6.20	6.10	21	6.10	.....	6.10	6.20	.....
6	.....	6.00	6.10	6.20	6.10	22	6.10	.....	6.10	6.20	.....
7	6.10	6.00	6.10	6.20	6.10	23	6.05	.....	6.10	6.20	.....
8	6.10	6.00	6.10	6.20	6.10	24	6.05	.....	6.10	6.20	.....
9	6.10	6.00	6.15	6.20	6.10	25	6.05	.....	6.10	6.20	.....
10	6.10	6.00	6.15	6.15	6.10	26	6.70	.....	6.10	6.20	.....
11	6.10	.....	6.30	6.15	.....	27	6.70	6.10	6.10	6.20	.....
12	6.10	.....	6.30	6.15	.....	28	6.00	6.10	6.10	6.20	.....
13	6.10	.....	6.20	6.15	.....	29	6.00	6.10	6.10	6.20	.....
14	6.10	.....	6.15	6.15	.....	30	6.00	6.10	6.10	6.20	.....
15	6.10	.....	6.20	6.11	.....	31	6.00	.....	6.10	.....	.....
16	6.10	.....	6.20	6.11	.....						

LOST RIVER AT MERRILL, OREG.

Discharge measurements of Lost River at Merrill, Oreg., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
September 6	T. H. Humphreys	3.55	159
September 26	C. T. Darley	3.50	163
October 20	T. H. Humphreys	3.50	145
November 5	C. T. Darley	3.40	147
November 27	do	3.48	158
December 17	do	3.45	147

Mean daily gage height, in feet, of Lost River at Merrill, Oreg., for 1904.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		3.70	3.60	3.55	3.50	3.50	17		3.70	3.55	3.55	3.50	3.50
2		3.70	3.60	3.55	3.50	3.50	18		3.70	3.55	3.55	3.50	3.50
3		3.70	3.60	3.55	3.50	3.50	19		3.70	3.55	3.50	3.50	3.50
4		3.70	3.60	3.55	3.50	3.50	20		3.70	3.55	3.50	3.50	3.50
5		3.70	3.60	3.55	3.50	3.50	21		3.70	3.55	3.50	3.50	3.50
6		3.70	3.55	3.55	3.50	3.50	22		3.70	3.55	3.50	3.50	3.50
7		3.70	3.55	3.55	3.50	3.50	23		3.70	3.55	3.50	3.50	3.50
8		3.70	3.55	3.55	3.50	3.50	24		3.70	3.55	3.50	3.50	3.50
9		3.70	3.55	3.55	3.50	3.50	25		3.70	3.55	3.50	3.50	
10		3.70	3.55	3.55	3.50	3.50	26	3.70	3.70	3.55	3.50	3.50	
11		3.70	3.55	3.55	3.50	3.50	27	3.70	3.60	3.55	3.50	3.50	
12		3.70	3.55	3.55	3.50	3.50	28	3.70	3.60	3.55	3.50	3.50	
13		3.70	3.55	3.55	3.50	3.50	29	3.70	3.60	3.55	3.50	3.50	
14		3.70	3.55	3.55	3.50	3.50	30	3.70	3.60	3.55	3.50	3.50	
15		3.70	3.55	3.55	3.50	3.50	31	3.70	3.60		3.50		
16		3.70	3.55	3.55	3.50	3.50							

KLAMATH RIVER AT KENO, OREG.

Discharge measurements of Klamath River at Keno, Oreg., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
May 31	J. H. Lewis and Ivan Landis	15.15	8,321
June 5	do	15.05	8,230
June 18	T. H. Humphreys	14.65	7,205
August 12	do	13.00	2,571
September 17	do	12.40	1,791
September 28	C. T. Darley	12.40	1,721
October 19	do	12.50	1,900
November 3	do	12.60	1,938
November 26	do	12.65	2,161

Mean daily gage height, in feet, of Klamath River at Keno, Oreg., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	15.10	14.20	13.30	12.70	12.40	12.60	12.70
2	.....	15.10	14.10	13.30	12.60	12.40	12.60	12.70
3	.....	15.10	14.10	13.30	12.60	12.40	12.60	12.70
4	.....	15.05	14.10	13.20	12.60	12.40	12.60	12.70
5	.....	15.00	14.05	13.20	12.60	12.40	12.60	12.70
6	.....	15.00	14.00	13.20	12.60	12.40	12.60	12.70
7	.....	15.00	14.00	13.10	12.50	12.40	12.60	12.70
8	.....	14.90	14.00	13.10	12.50	12.40	12.60	12.70
9	.....	14.90	14.00	13.10	12.50	12.50	12.60	12.70
10	.....	14.90	13.90	13.00	12.50	12.50	12.60	12.80
11	.....	14.90	13.90	13.00	12.50	12.50	12.60	12.80
12	.....	14.90	13.90	13.00	12.40	12.40	12.60	12.80
13	.....	14.80	13.80	13.00	12.40	12.40	12.60	12.80
14	.....	14.80	13.80	13.00	12.40	12.40	12.60	12.80
15	.....	14.80	13.80	13.00	12.40	12.40	12.60	12.80
16	.....	14.80	13.80	13.00	12.40	12.40	12.60	12.80
17	.....	14.70	13.80	12.90	12.40	12.50	12.60	12.80
18	.....	14.70	13.80	12.90	12.40	12.50	12.60	12.80
19	.....	14.60	13.70	12.90	12.40	12.50	12.60	12.80
20	.....	14.60	13.70	12.90	12.40	12.50	12.60	12.80
21	.....	14.60	13.70	12.90	12.40	12.50	12.70	12.80
22	.....	14.60	13.60	12.80	12.40	12.50	12.70	12.80
23	.....	14.50	13.60	12.80	12.40	12.50	12.70	12.80
24	.....	14.50	13.60	12.80	12.40	12.50	12.70	12.80
25	.....	14.40	13.50	12.80	12.40	12.50	12.70	.....
26	.....	14.40	13.50	12.80	12.40	12.50	12.70	.....
27	.....	14.40	13.50	12.70	12.40	12.50	12.70	.....
28	.....	14.30	13.40	12.70	12.40	12.50	12.70	.....
29	.....	14.30	13.40	12.70	12.40	12.50	12.70	.....
30	.....	14.20	13.40	12.70	12.40	12.50	12.70	.....
31	15.10	.....	13.40	12.70	.....	12.50	.....	.....

KLAMATH RIVER AT KLAMATH FALLS, OREG.

Discharge measurements of Klamath River at Klamath Falls, Oreg., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
May 15	J. H. Lewis and Ivan Landis	7.15	9,073
June 7	do	6.55	7,342
August 25	T. H. Humphreys	3.70	1,915
September 16	C. T. Darley	3.40	1,782
September 28	do	3.30	2,005
October 18	do	3.40	2,135
November 8	do	3.50	1,968
November 24	do	3.60	1,898

Mean daily gage height, in feet, of Klamath River at Klamath Falls, Oreg., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	6.75	5.50	4.35	3.50	3.30	3.50	3.55
2	.....	6.80	5.45	4.30	3.50	3.30	3.45	3.60
3	.....	6.70	5.40	4.25	3.50	3.30	3.45	3.60
4	.....	6.70	5.40	4.20	3.45	3.30	3.45	3.60
5	.....	6.65	5.35	4.20	3.45	3.30	3.45	3.65
6	.....	6.60	5.30	4.15	3.45	3.30	3.50	3.70
7	.....	6.55	5.30	4.15	3.45	3.30	3.50	3.70
8	.....	6.55	5.25	4.15	3.45	3.35	3.50	3.70
9	.....	6.50	5.25	4.10	3.40	3.40	3.50	3.70
10	.....	6.45	5.20	4.05	3.40	3.40	3.50	3.70
11	.....	6.40	5.20	4.05	3.40	3.40	3.55	3.70
12	.....	6.40	5.15	4.00	3.40	3.35	3.55	3.70
13	.....	6.35	5.10	4.00	3.35	3.35	3.60	3.75
14	.....	6.30	5.10	3.95	3.35	3.40	3.50	3.75
15	7.15	6.30	5.05	3.95	3.35	3.40	3.50	3.80
16	7.10	6.25	5.00	3.90	3.35	3.45	3.50	3.80
17	7.10	6.20	4.95	3.85	3.35	3.40	3.50	3.80
18	7.15	6.10	4.90	3.85	3.30	3.40	3.50	3.80
19	7.10	6.05	4.85	3.80	3.30	3.45	3.55	3.80
20	7.10	6.00	4.80	3.80	3.30	3.45	3.50	3.80
21	7.10	6.00	4.80	3.75	3.30	3.45	3.50	3.80
22	7.05	5.95	4.75	3.75	3.45	3.45	3.55	3.85
23	7.00	5.85	4.75	3.70	3.40	3.45	3.55	3.90
24	7.00	5.80	4.75	3.70	3.35	3.45	3.60	3.95
25	6.95	5.75	4.70	3.70	3.30	3.45	3.60	.....
26	6.90	5.75	4.65	3.65	3.30	3.45	3.60	.....
27	6.90	5.70	4.60	3.65	3.25	3.45	3.60	.....
28	6.90	5.65	4.55	3.60	3.30	3.45	3.60	.....
29	6.85	5.60	4.50	3.55	3.20	3.45	3.60	.....
30	6.85	5.55	4.45	3.55	3.20	3.45	3.65	.....
31	6.80	.....	4.40	3.55	.....	3.45	.....	.....

SPRAGUE RIVER AT YAINAX, OREG.

Mean daily gage height, in feet, of Sprague River at Yainax, Oreg., for 1904.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	18.80	14.11	14.60	14.20	13.11	13.80	14.50
2	18.80	14.11	14.50	14.20	13.11	13.80	14.50
3	18.70	14.11	14.80	14.20	13.11	13.90	14.60
4	18.70	14.10	14.80	.....	13.11	13.90	14.60
5	18.70	14.10	14.70	.....	14.00	13.90	14.60
6	18.60	14.90	14.70	.....	14.10	13.90	14.50
7	18.60	14.80	14.80	.....	14.00	13.90	14.50
8	18.50	14.80	14.80	.....	14.10	13.10	14.50
9	18.50	14.70	14.80	.....	14.10	13.10	14.50
10	18.40	14.70	14.70	.....	14.20	13.10	14.60
11	18.30	14.60	14.70	.....	14.30	13.11	14.60
12	18.20	14.50	14.70	.....	14.10	13.11	14.60
13	18.10	14.50	14.60	.....	14.10	13.11	14.60
14	17.70	14.40	14.60	.....	14.00	14.00	14.70
15	17.60	14.40	14.50	.....	14.00	14.00	14.70
16	17.40	14.30	14.50	.....	14.00	14.10	14.70
17	17.40	14.30	14.50	.....	14.00	14.20	14.80
18	17.30	14.30	14.50	.....	14.00	14.20	14.80
19	17.20	14.60	14.50	.....	13.11	14.20	14.70
20	17.10	14.60	14.50	.....	13.10	14.20	14.70
21	16.11	14.80	14.50	.....	13.10	14.20	14.60
22	16.10	14.80	14.50	.....	13.10	14.40	14.60
23	16.10	14.80	14.40	.....	13.90	14.40	14.50
24	16.90	14.70	14.40	.....	13.90	14.30	14.50
25	16.80	14.60	14.40	.....	13.90	14.30	.....
26	16.70	14.50	14.40	.....	13.80	14.30	.....
27	16.60	14.50	14.40	.....	13.80	14.40	.....
28	16.40	14.40	14.40	.....	13.80	14.40	.....
29	16.20	14.40	14.30	.....	13.70	14.50	.....
30	15.00	14.50	14.30	.....	13.70	14.50	.....
31	.....	14.50	14.30	.....	13.80	.....	.....

UPPER KLAMATH LAKE NEAR PELICAN, OREG.

Mean daily gage height, in feet, of Upper Klamath Lake near Pelican, Oreg., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	5.70	4.50	3.85	3.40	3.40	17	.....	5.10	4.15	3.50	3.40	3.35
2	.....	5.65	4.55	3.85	3.35	3.35	18	.....	5.05	4.20	3.55	3.35	3.30
3	.....	5.65	4.50	3.85	3.40	3.35	19	.....	5.00	4.10	3.50	3.35	3.40
4	.....	5.60	4.50	3.75	3.40	3.30	20	.....	4.95	4.10	3.45	3.50	3.45
5	.....	5.60	4.45	3.75	3.40	3.30	21	.....	4.90	4.05	3.45	3.40	3.50
6	.....	5.55	4.55	3.80	3.35	3.25	22	.....	4.85	4.05	3.45	3.50	3.45
7	.....	5.50	4.45	3.85	3.40	3.30	23	.....	4.80	4.05	3.40	3.60	.....
8	.....	5.50	4.30	3.85	3.40	3.30	24	.....	4.75	4.00	3.40	3.60	.....
9	.....	5.45	4.35	3.85	3.40	3.40	25	.....	4.70	4.05	3.40	3.55	.....
10	.....	5.40	4.40	3.70	3.30	3.45	26	.....	4.70	3.95	3.45	3.50	.....
11	.....	5.35	4.20	3.65	3.35	3.50	27	.....	4.70	3.90	3.40	3.50	.....
12	.....	5.30	4.30	3.70	3.40	3.45	28	5.80	4.65	3.95	3.35	3.45	.....
13	.....	5.25	4.35	3.75	3.35	3.40	29	5.80	4.60	3.95	3.40	3.50	.....
14	.....	5.20	4.30	3.70	3.35	3.35	30	5.75	4.60	3.85	3.40	3.40	.....
15	.....	5.20	4.20	3.75	3.35	3.30	31	5.70	.....	3.90	3.45	.....	.....
16	.....	5.15	4.20	3.65	3.40	3.30							

TULE LAKE NEAR MERRILL, OREG.

Mean daily gage height, in feet, of Tule Lake near Merrill, Oreg., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1								
2						8.80		
3								
4								8.50
5								
6								
7								
8								
9						8.80		
10		10.40						
11					9.00			
12								
13								
14								
15				9.40			8.65	
16			10.10					
17	10.50							
18					8.90			
19								
20								
21								
22				9.25				
23								
24								
25								
26								
27								
28								
29	10.70							
30								
31				9.10				

MISCELLANEOUS MEASUREMENTS IN KLAMATH RIVER DRAINAGE BASIN.

[By T. H. Humphreys, J. H. Lewis, and C. T. Darley.]

Miscellaneous measurements in Klamath River drainage basin.

Date.	Gage height.	Stream.	Location.	Discharge.
1903.	*Feet.*			*Sec.-feet.*
October 24[a]		Klamath River	Klamathon	2,000
1904.				
June 14		Antelope Creek	At head	[b] 155
June 13		Butte Creek	¼ mile above Wm. Bray's house, Cal.	148
June 15		do	1 mile above Boyce ranch, Cal.	124

[a] Measurement made by H. E. Green. [b] Estimated.

Miscellaneous measurements in Klamath River drainage basin—Continued.

Date.	Gage height.	Stream.	Location.	Discharge.
1904.	*Feet.*			*Sec.-feet.*
June 8		Little Shasta	Table Rock, Cal	117
June 8		Ankney canal	Klamath Falls, Oreg	32
August 15		do	do	48
August 15		do	7 miles below intake, Klamath Falls, Oreg.	37
August 15		do	Klamath Falls, Oreg	40
August 27		do	do	43
August 27		do	do	29
August 27		do	7 miles below intake, Klamath Falls, Oreg.	33
August 27		Lateral of Ankney canal.	Klamath Falls, Oreg	4.8
May 20		Miller Creek	Lorella, Oreg	326
October 2		Adams ditch	Merrill, Oreg	26
May 23	5.8	Lost River	Olene, Oreg	961
June 10	4.9	do	do	322
May 19	8.9	do	Langells Valley, Oreg	746
May 21	12.4	Sprague River	10 miles above Yainax, Oreg.	2,075
June 12	10.9	do	do	1,081
May 25		Williamson River	Bridge near junction with Sprague River, Oreg.	2,091
May 26		Wood River	Fort Klamath, Oreg	450
May 22	9.3	Sprague River	5 miles below Yainax, Oreg.	3,915

MISCELLANEOUS MEASUREMENTS IN NORTHERN PACIFIC OCEAN DRAINAGE BASIN.[a]

Miscellaneous measurements in Northern Pacific Ocean drainage basin.

MAD RIVER DRAINAGE.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Sec.-feet.*
Oct. 20	S. G. Bennett	Mad River	Vance, Cal	53

[a] In this system are included streams which drain directly into the Pacific Ocean.

Miscellaneous measurements in Northern Pacific Ocean drainage basin—Continued.

EEL RIVER DRAINAGE.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Sec.-feet.*
Oct. 21	S. G. Bennett	Eel River	Stingleys station	189

RUSSIAN RIVER DRAINAGE.

1903.				
Jan. 22	S. G. Bennett	Russian River	Healdsburg	628

PAJARO RIVER DRAINAGE.

1904.				
Dec. 13	W. B. Clapp Geo. Senger	San Benito River	Kehlo ranch, 7 miles above Hollister.	1.6

THE GREAT BASIN DRAINAGE.

Under this head is comprised a limited area of arid country in California lying on the eastern slope of the Sierra Nevadas. These areas include the Susan and Owens river drainage basins. Having no outlet to the sea, the entire drainage of these basins is lost mainly through evaporation from the lakes and sinks in which the waters of these rivers collect.

Susan River has its source in the Sierra Nevada in northeastern California, and flows eastward, discharging into Honey Lake—one of the landlocked lakes of the Great Basin—of which it is the principal feeder. A considerable area of land is irrigated from the waters of the river below the gaging station, and during the last ten or twelve years several projects have been started for irrigating other extensive areas by the storage of its waters both above and below the town of Susanville.

Owens River has its source in the Sierra Nevada in eastern California, and flowing southerly parallel with this range its discharge is gradually increased by numerous tributaries until it finally discharges into Owens Lake. A considerable area of land is irrigated from the waters of the river and tributaries. Numerous gaging stations are maintained on the river, canals, and creek, and during the last two years extensive investigations have been made by the Reclamation Service of the United States Geological Survey for the construction of storage reservoirs and an irrigation system.

The following pages give the results of data collected at these stations during 1904:

SUSAN RIVER NEAR SUSANVILLE, CAL.

This station was established June 3, 1900, by L. H. Taylor, at which time a temporary gage was installed on the right bank. It is located about three-fourths of a mile southwest of Susanville, at the electric-light plant. A short distance above the station a small irrigating ditch, known as the "Masten ditch," is taken out on the right bank. There is a flume near its head in which a gage has been placed. On December 20, 1903, the station at the electric-light plant was reestablished by H. E. Green. A new gage was set which was made to read 2 feet more than original gage. A cable was installed for high-water measurements. The initial point for soundings is a post in the fence in line with the cable. The cable support on the left bank is 34.8 feet from the initial point for soundings. The channel is straight for 150 feet above and for 250 feet below the cable. The current is swift, There is a riffle immediately above the cable. The right bank is high and is composed of clay covered with vegetation. It is not liable to overflow. The left bank is low, liable to overflow, and is covered with a sparse growth of willows. The bed of the stream is composed of gravel and cobblestones and is permanent. Bench mark No. 1 is a nail in the fence post, which is used as the initial point for soundings. Its elevation is 11.35 feet above the zero of the gage. Bench mark No. 2 is a nail in the cable post. Its elevation is 9.00 feet above the zero of the gage. Bench mark No. 3 is a nail in the cottonwood tree to which the cable is attached. Its elevation is 10.00 feet above the zero of the gage. The gage is read once each day by James Branham.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Susan River near Susanville, Cal., in 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
February 21	James Branham	5.30	106
February 28	do	6.40	298
March 29	do	7.55	716
June 16	S. G. Bennett and J. S. Evans	5.60	180
June 29	James Branham	4.95	96
July 31	do	4.20	27
August 10	do	4.50	53
September 11	do	3.85	11
October 25	W. B. Clapp and J. Y. Toler	4.10	23

Mean daily gage height, in feet, of Susan River near Susanville, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.30	4.20	6.20	6.85	6.25	6.05	4.90	4.10	3.90	4.00	4.10	4.30
2	4.25	4.20	6.80	6.90	6.15	6.00	5.20	4.10	3.85	4.00	4.20	4.30
3	4.25	4.20	7.00	6.90	6.15	5.95	5.20	4.05	3.80	4.00	4.10	4.20
4	4.25	4.20	7.55	7.05	6.20	5.90	5.20	4.20	3.80	4.00	4.10	4.10
5	4.20	4.25	7.20	7.00	6.30	5.90	5.10	4.50	3.80	4.00	4.10	4.10
6	4.20	4.25	7.45	7.15	6.85	5.80	5.15	4.50	3.80	4.00	4.10	4.10
7	4.20	4.25	7.80	7.15	7.30	5.80	5.10	4.50	3.80	4.10	4.10	4.10
8	4.20	4.25	8.70	7.30	7.35	5.75	4.65	4.50	3.80	4.10	4.10	4.10
9	4.20	4.25	7.75	7.45	7.50	5.70	4.50	4.50	3.80	4.10	4.10	4.10
10	4.25	4.25	7.50	7.80	7.55	5.70	4.50	4.50	3.80	4.20	4.10	4.10
11	4.30	4.25	7.00	8.05	7.80	5.60	4.40	4.40	3.90	4.55	4.10	4.05
12	4.30	4.30	6.70	8.25	7.95	5.50	4.40	4.40	3.95	4.40	4.10	4.05
13	4.30	4.30	6.45	8.60	8.15	5.50	4.35	4.40	3.95	4.30	4.10	4.10
14	4.30	4.30	6.55	8.80	8.20	5.50	4.30	4.40	3.95	4.30	4.10	4.10
15	4.25	5.60	6.70	8.95	8.10	5.45	4.30	4.40	3.95	4.20	4.10	4.10
16	4.25	9.00	6.35	8.50	8.05	5.50	4.30	4.40	3.95	4.25	4.20	4.10
17	4.25	6.70	7.85	8.25	7.90	5.50	4.30	4.40	3.95	4.25	4.20	4.05
18	4.25	6.20	8.80	8.25	7.85	5.40	4.30	4.40	3.95	4.20	4.15	4.05
19	4.25	5.65	9.00	8.30	7.55	5.40	4.30	4.40	4.00	4.20	4.15	4.00
20	4.30	5.35	8.45	7.75	7.40	5.35	4.30	4.40	4.00	4.15	4.15	4.00
21	4.30	5.85	7.75	7.45	7.40	5.30	4.25	4.40	4.00	4.15	4.10	4.00
22	4.30	9.90	7.45	7.25	7.30	5.30	4.20	4.40	4.00	4.10	4.10	4.00
23	4.30	7.85	7.10	7.05	7.30	5.30	4.20	4.40	4.20	4.10	4.10	4.05
24	4.30	9.65	6.80	6.90	7.30	5.30	4.30	4.40	4.40	4.10	4.10	4.05
25	4.30	8.20	6.70	6.85	7.20	5.20	4.60	4.40	4.30	4.10	4.10	4.05
26	4.30	7.50	6.65	6.80	7.05	5.10	4.55	4.25	4.20	4.10	4.10	4.10
27	4.25	6.95	6.70	6.75	6.80	5.00	4.50	4.00	4.10	4.10	4.25	4.10
28	4.20	6.40	7.85	6.65	6.70	5.00	4.45	4.00	4.10	4.10	4.20	4.10
29	4.20	6.20	7.55	6.65	6.50	4.90	4.45	3.95	4.05	4.10	4.20	4.10
30	4.20	.....	7.30	6.25	6.40	4.90	4.40	3.90	4.05	4.10	4.20	7.60
31	4.20	.....	6.95	.....	6.25	.....	4.25	3.90	.....	4.10	.....	5.45

Estimated monthly discharge of Susan River near Susanville, Cal., 1904.

[Drainage area, 256 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	30	24	27	1,660	0.11	0.13
February	1,750	24	349	20,075	1.36	1.47
March	1,300	300	629	38,676	2.46	2.84
April	1,275	312	695	41,355	2.71	3.02
May	960	288	600	36,893	2.34	2.70
June	262	80	160	9,521	.62	.69
July	116	27	51	3,136	.20	.23
August	42	13	31	1,906	.12	.14
September	36	10	16	952	.06	.07
October	46	16	22	1,353	.09	.10
November	27	20	21	1,250	.08	.09
December	725	16	47	2,890	.18	.21
The year	1,750	10	221	159,667	.86	11.69

WILLOW CREEK AT MERRILLVILLE, CAL.

This station was established June 18, 1904, by S. G. Bennett. It is located at old bridge 100 feet above present wagon bridge. The gage is a 2 by 4 inch vertical rod fastened to the left end of the bridge. It is read once each day by R. W. Hurlbut. Discharge measurements are made from the bridge. The initial point for soundings is on the left bank of the stream. The distance across stream is marked on the foot bridge at intervals of 2 feet. The channel is straight above and below the bridge for a distance of 100 feet. The banks on each side are low, but not subject to overflow, as there is very little fluctuation in the discharge of the creek. The bed of the stream is composed of gravel and is not subject to much change.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Willow Creek at Merrillville, Cal., 1904.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
June 18	S. G. Bennett	1.00	19.0
July 17	James Branham	.95	14.9
August 29	do	1.05	17.9
October 25	J. Y. Toler and W. B. Clapp	1.07	19.3

Mean daily gage height, in feet, of Willow Creek at Merrillville, Cal., for 1904.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.00	1.00	1.00	1.05	1.10	1.10
2	1.00	1.00	1.10	1.05	1.10	1.10
3	1.00	1.05	1.10	1.05	1.10	1.05
4	1.00	1.00	1.05	1.05	1.10	1.05
5	1.00	1.00	1.05	1.05	1.10	1.05
6	1.05	1.00	1.05	1.10	1.05	1.05
7	1.00	.95	1.10	1.10	1.10	1.05
8	1.00	1.05	1.05	1.05	1.05	1.05
9	1.00	1.05	1.05	1.10	1.10	1.10
10	.95	1.00	1.10	1.10	1.10	1.05
11	1.10	1.00	1.05	1.05	1.10	1.05
12	1.15	1.00	1.00	1.05	1.10	1.05
13	1.20	1.00	1.00	1.05	1.10	1.10
14	1.10	1.00	1.05	1.10	1.10	1.10
15	1.10	1.00	1.05	1.20	1.10	1.05
16	1.10	1.00	1.05	1.10	1.10	1.05
17	1.00	1.05	1.05	1.05	1.05	1.05
18	1.00	1.00	1.05	1.05	1.10	1.05
19	1.00	1.00	1.00	1.05	1.10	1.05
20	1.00	1.00	1.00	1.05	1.10	1.05
21	1.05	1.00	1.05	1.05	1.10	1.05
22	1.00	1.00	1.05	1.05	1.10	1.05

Mean daily gage height, in feet, of Willow Creek at Merrillville, Cal., for 1904—Continued.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
23	1.00	1.00	1.10	1.05	1.05	1.10
24	1.00	1.00	1.10	1.05	1.05	1.10
25	1.00	1.05	1.10	1.05	1.05	1.05
26	1.00	1.00	1.05	1.05	1.05	1.00
27	1.00	1.00	1.05	1.10	1.10	1.05
28	1.00	1.00	1.05	1.05	1.10	1.05
29	1.05	1.00	1.05	1.10	1.10	1.20
30	1.00	1.05	1.00	1.10	1.10	1.70
31	1.00	1.00	.....	1.10	.....	1.20

Estimated monthly discharge of Willow Creek at Merrillville, Cal., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
July	22	17	19	1,168
August	19	17	18	1,107
September	20	18	19	1,131
October	22	19	19	1,168
November	20	19	20	1,190
December	50	19	20	1,230
The period	50	17	19	6,994

OWENS RIVER NEAR ROUND VALLEY, CAL.

This station was established by J. C. Clausen, assisted by R. S. Hawley, on August 3, 1903. It is located at the footbridge, 700 feet above the junction of Owens River and Rock Creek. The river at this point cuts through a lava deposit about 100 feet thick and forms a gorge which is about 250 feet wide at the top. The gage is a 1 by 4 inch vertical rod, fastened to the concrete bridge abutment on the left bank. It is read once each day by Roscoe Jones. Discharge measurements are made from the single-span footbridge to which the gage is attached. The bridge is 37 feet long and has a clear span of 35 feet. The initial point for soundings is the anchor bolt of the right abutment. The channel is straight for 175 feet above and for 250 feet below the station. The current is swift at all stages. Both banks are high and rocky and are not liable to overflow. The bed of the stream is composed of rock and lava bowlders and is not subject to much change. The bench mark is a bolt set in a lava bowlder 97.4 feet north of the right abutment.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, hydrographers.

Discharge measurements of Owens River near Round Valley, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
August 3	R. S. Hawley	1.80	161
August 9	do	1.85	160
August 18	do	1.75	159
August 22	do	1.75	160
September 1	do	1.74	159
September 12	do	1.80	175
October 8	do	1.85	185
October 25	do	1.82	173
November 24	do	1.88	196
December 29	do	1.70	151
1904.			
January 25	R. S. Hawley	1.80	184
March 2	do	2.20	270
March 28	do	2.85	458
April 8	E. C. Murphy, S. G. Bennett, and R. S. Hawley.	1.87	186
April 27	R. S. Hawley	1.82	190
June 2	do	2.57	383
June 15	do	3.10	564
July 13	J. C. Clausen and L. M. Barnes	2.55	380
August 3	L. M. Barnes	2.40	324
September 9	R. S. Hawley	2.01	232
October 13	R. S. Hawley, W. B. Clapp, and R. J. Taylor	2.25	269
November 12	R. J. Taylor	2.00	218
December 6	do	1.85	155

Mean daily gage height, in feet, of Owens River near Round Valley, Cal., for 1903 and 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
1	.....	.....	.....	.....	.....	.....	.....	.....	1.75	1.77	1.80	1.80
2	.....	.....	.....	.....	.....	.....	.....	.....	1.75	1.80	1.80	1.80
3	.....	.....	.....	.....	.....	.....	.....	.....	1.75	1.80	1.80	1.80
4	.....	.....	.....	.....	.....	.....	.....	1.80	1.73	1.83	1.80	1.70
5	.....	.....	.....	.....	.....	.....	.....	1.80	1.70	1.80	1.80	1.70
6	.....	.....	.....	.....	.....	.....	.....	1.80	1.72	1.80	1.75	1.70
7	.....	.....	.....	.....	.....	.....	.....	1.80	1.73	1.80	1.70	1.70
8	.....	.....	.....	.....	.....	.....	.....	1.80	1.75	1.82	1.70	1.70
9	.....	.....	.....	.....	.....	.....	.....	1.85	1.77	1.80	1.70	1.70
10	.....	.....	.....	.....	.....	.....	.....	1.80	1.80	1.83	1.70	1.70
11	.....	.....	.....	.....	.....	.....	.....	1.80	1.80	1.80	1.70	1.70
12	.....	.....	.....	.....	.....	.....	.....	1.90	1.80	1.80	1.70	1.70
13	.....	.....	.....	.....	.....	.....	.....	1.90	1.80	1.80	1.70	1.70
14	.....	.....	.....	.....	.....	.....	.....	1.90	1.80	1.82	1.70	1.70
15	.....	.....	.....	.....	.....	.....	.....	1.80	1.80	1.80	1.70	1.70
16	.....	.....	.....	.....	.....	.....	.....	1.80	1.80	1.80	1.70	1.80
17	.....	.....	.....	.....	.....	.....	.....	1.80	1.70	1.80	1.70	1.80
18	.....	.....	.....	.....	.....	.....	.....	1.75	1.80	1.80	1.70	1.80
19	.....	.....	.....	.....	.....	.....	.....	1.75	1.80	1.80	1.70	1.80
20	.....	.....	.....	.....	.....	.....	.....	1.75	1.80	1.80	1.70	1.80
21	.....	.....	.....	.....	.....	.....	.....	1.68	1.80	1.80	1.70	1.80
22	.....	.....	.....	.....	.....	.....	.....	1.72	1.80	1.80	1.70	1.80
23	.....	.....	.....	.....	.....	.....	.....	1.80	1.80	1.80	1.80	1.80
24	.....	.....	.....	.....	.....	.....	.....	1.75	1.78	1.80	1.90	1.80
25	.....	.....	.....	.....	.....	.....	.....	1.80	1.77	1.80	1.90	1.80
26	.....	.....	.....	.....	.....	.....	.....	1.80	1.80	1.80	1.80	1.80
27	.....	.....	.....	.....	.....	.....	.....	1.78	1.80	1.80	1.80	1.70
28	.....	.....	.....	.....	.....	.....	.....	1.72	1.80	1.80	1.80	1.70
29	.....	.....	.....	.....	.....	.....	.....	1.70	1.80	1.80	1.80	1.70
30	.....	.....	.....	.....	.....	.....	.....	1.70	1.78	1.80	1.80	1.70
31	.....	.....	.....	.....	.....	.....	.....	1.70	.....	1.70	.....	1.70
1904.												
1	1.70	1.85	2.20	2.00	1.80	2.60	3.00	2.70	2.30	2.30	2.15	2.10
2	1.70	1.85	2.20	2.00	1.80	2.60	2.90	2.60	2.25	2.30	2.15	2.10
3	1.70	1.80	2.20	2.00	1.80	2.80	3.00	2.50	2.20	2.20	2.15	2.10
4	1.70	1.85	2.20	1.90	1.80	2.90	3.00	2.50	2.10	2.20	2.20	2.10
5	1.70	1.85	2.20	1.90	1.85	2.90	3.00	2.45	2.10	2.15	2.30	2.10
6	1.70	1.80	2.20	1.90	1.90	3.00	3.00	2.40	2.10	2.10	2.20	2.10
7	1.70	1.80	2.10	1.90	1.95	3.00	2.90	2.50	2.20	2.15	2.10	2.00
8	1.70	1.80	2.10	1.90	2.00	2.90	2.90	2.60	2.20	2.20	2.10	2.00
9	1.70	1.85	1.90	1.90	2.00	2.90	2.90	2.70	2.15	2.20	2.10	2.00
10	1.70	1.85	2.00	1.90	2.10	3.00	2.90	2.70	2.15	2.25	2.10	2.00
11	1.70	1.90	2.00	1.90	2.10	3.00	2.85	2.60	2.15	2.30	2.10	2.00
12	1.70	1.90	1.90	1.90	2.20	3.00	2.85	2.60	2.10	2.30	2.10	2.00
13	1.70	1.90	1.90	2.00	2.20	3.00	2.90	2.60	2.00	2.25	2.10	2.00
14	1.70	2.00	1.90	2.10	2.20	3.00	2.80	2.60	2.00	2.25	2.10	2.00
15	1.70	1.95	2.20	2.00	2.40	3.10	2.60	2.45	2.10	2.20	2.10	2.05
16	1.70	2.50	2.20	2.00	2.50	3.40	2.60	2.55	2.10	2.20	2.10	2.05
17	1.70	2.25	2.20	1.90	2.50	3.40	2.55	2.50	2.10	2.10	2.10	2.05
18	1.70	1.95	2.20	1.90	2.50	3.30	2.55	2.45	2.10	2.00	2.10	2.05
19	1.70	1.90	2.20	2.00	2.50	3.30	2.50	2.40	2.00	2.15	2.10	2.00
20	1.70	2.00	2.20	1.90	2.40	3.40	2.50	2.25	2.00	2.15	2.10	2.00
21	1.70	1.95	2.20	1.90	2.40	3.30	2.50	2.30	2.00	2.20	2.10	1.95
22	1.70	2.00	2.20	1.90	2.40	3.30	2.65	2.25	2.00	2.15	2.10	1.90
23	1.70	2.30	2.20	1.90	2.40	3.20	2.70	2.25	2.10	2.15	2.10	1.85
24	1.75	2.30	2.10	1.85	2.50	3.30	2.60	2.30	2.90	2.15	2.10	1.80
25	1.80	2.30	2.10	1.85	2.70	3.20	2.55	2.30	2.95	2.15	2.00	1.80
26	1.80	2.30	2.10	1.90	2.80	3.10	2.55	2.30	2.60	2.15	2.00	1.80
27	1.70	2.20	2.10	1.90	2.80	3.20	2.70	2.30	2.55	2.15	2.00	1.90
28	1.80	2.00	2.85	1.90	2.80	3.20	2.70	2.30	2.45	2.15	2.00	1.95
29	1.80	2.00	2.60	1.85	2.60	3.10	2.65	2.30	2.40	2.10	2.00	1.90
30	1.80	.....	2.00	1.80	2.60	3.10	2.70	2.30	2.40	2.10	2.00	2.00
31	1.85	.....	1.95	.....	2.55	.....	2.80	2.25	.....	2.10	.....	2.00

Rating table for Owens River near Round Valley, Cal., from August 4, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.60	132	2.20	272	2.70	412	3.20	568
1.70	152	2.30	298	2.80	442	3.30	601
1.80	172	2.40	325	2.90	473	3.40	636
1.90	196	2.50	353	3.00	504	3.50	675
2.00	221	2.60	382	3.10	536	3.60	715
2.10	246						

Estimated monthly discharge of Owens River near Round Valley, Cal., for 1903 and 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
1903.				
August 4–31	196	148	169	9,386
September	172	152	167	9,937
October	179	152	172	10,576
November	196	152	163	9,699
December	172	152	161	9,900
The period				49,498
1904.				
January	184	152	156.6	9,629
February	353	172	220.9	12,706
March	458	196	259.7	15,968
April	246	172	201.5	11,990
May	442	172	299.5	18,416
June	635	382	532	31,656
July	504	353	428	26,317
August	412	285	336	20,660
September	489	221	281	16,721
October	298	221	266	16,356
November	298	221	246	14,638
December	246	172	218	13,404
The year	635	152	287	208,461

ROCK CREEK NEAR ROUND VALLEY, CAL.

This station was established August 3, 1903, by J. C. Clausen and R. S. Hawley. It is located at the wagon bridge on the road from Long Valley to Bishop, 3,500 feet above the mouth of the creek. The gage is a 1 by 4 inch vertical rod fastened to the left end of the bridge. It is read once each day by Roscoe Jones. Discharge measurements are made from a footbridge which has a span of 18 feet. The initial point for soundings is on right bank of stream. The distances across stream are marked on the footbridge at intervals of 2 feet. The channel is straight for 50 feet above and for 40 feet below the footbridge. The current is swift. Both banks are high and rocky and are not liable to overflow. The bed of the stream is composed of gravel and is not subject to much change. The bench mark is a point marked on a lava rock 15 feet east of the left end of the footbridge.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Rock Creek near Round Valley, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
August 3	R. S. Hawley	1.55	20.0
August 8	do	1.62	21.0
August 18	do	1.55	19.5
September 1	do	1.42	16.8
September 10	do	1.49	17.5
November 24	do	1.51	18.3
December 29	do	1.45	18.1
1904.			
March 4	R. S. Hawley	1.20	14.3
March 28	do	1.40	26
April 8	E. C. Murphy, S. G. Bennett, and R. S. Hawley	1.28	22
April 27	R. S. Hawley	1.10	15.3
June 2	do	2.40	64
June 15	do	2.76	98
July 13	J. C. Clausen and L. M. Barnes	2.00	54
August 3	L. M. Barnes	2.30	72
September 9	R. S. Hawley	1.30	22
October 13	W. B. Clapp, R. J. Taylor, and R. S. Hawley	1.90	50
November 12	R. J. Taylor	1.68	37
December 6	do	1.39	24

Mean daily gage height, in feet, of Rock Creek near Round Valley, Cal., for 1903 and 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
1	.....	.....	.....	.....	.....	.....	.....	.....	1.40	1.35	1.40	1.50
2	.....	.....	.....	.....	.....	.....	.....	.....	1.45	1.30	1.40	1.50
3	.....	.....	.....	.....	.....	.....	.....	.....	1.40	1.30	1.40	1.50
4	.....	.....	.....	.....	.....	.....	.....	[a]1.55	1.40	1.30	1.40	1.50
5	.....	.....	.....	.....	.....	.....	.....	1.50	1.40	1.35	1.40	1.50
6	.....	.....	.....	.....	.....	.....	.....	1.60	1.45	1.30	1.45	1.55
7	.....	.....	.....	.....	.....	.....	.....	1.60	1.40	1.30	1.50	1.55
8	.....	.....	.....	.....	.....	.....	.....	1.60	1.45	1.30	1.50	1.55
9	.....	.....	.....	.....	.....	.....	.....	1.55	1.45	1.30	1.50	1.55
10	.....	.....	.....	.....	.....	.....	.....	1.60	1.50	1.35	1.40	1.55
11	.....	.....	.....	.....	.....	.....	.....	1.60	1.55	1.30	1.40	1.60
12	.....	.....	.....	.....	.....	.....	.....	1.70	1.60	1.30	1.40	1.60
13	.....	.....	.....	.....	.....	.....	.....	1.70	1.60	1.30	1.40	1.60
14	.....	.....	.....	.....	.....	.....	.....	1.60	1.55	1.30	1.40	1.60
15	.....	.....	.....	.....	.....	.....	.....	1.50	1.50	1.30	1.40	1.60
16	.....	.....	.....	.....	.....	.....	.....	1.60	1.40	1.30	1.45	1.60
17	.....	.....	.....	.....	.....	.....	.....	1.60	[b]1.00	1.30	1.50	1.60
18	.....	.....	.....	.....	.....	.....	.....	1.55	1.50	1.30	1.50	1.60
19	.....	.....	.....	.....	.....	.....	.....	1.50	1.50	1.30	1.50	1.60
20	.....	.....	.....	.....	.....	.....	.....	1.50	1.50	1.30	1.50	1.60
21	.....	.....	.....	.....	.....	.....	.....	1.45	1.50	1.30	1.50	1.60
22	.....	.....	.....	.....	.....	.....	.....	1.50	1.55	1.30	1.50	1.50
23	.....	.....	.....	.....	.....	.....	.....	1.60	1.50	1.30	1.50	1.50
24	.....	.....	.....	.....	.....	.....	.....	1.60	1.50	1.30	1.50	1.55
25	.....	.....	.....	.....	.....	.....	.....	1.50	1.55	1.30	1.50	1.50
26	.....	.....	.....	.....	.....	.....	.....	1.50	1.50	1.30	1.50	1.50
27	.....	.....	.....	.....	.....	.....	.....	1.50	1.50	1.30	1.50	1.45
28	.....	.....	.....	.....	.....	.....	.....	1.45	1.40	1.30	1.50	1.45
29	.....	.....	.....	.....	.....	.....	.....	1.40	1.30	1.30	1.50	1.45
30	.....	.....	.....	.....	.....	.....	.....	1.40	1.30	1.40	1.50	1.45
31	.....	.....	.....	.....	.....	.....	.....	1.40	.....	1.40	.....	1.45
1904.												
1	1.55	1.5	1.3	1.3	1.2	2.4	2.4	2.25	1.4	1.9	1.75	1.45
2	1.55	1.5	1.25	1.3	1.2	2.4	2.4	2.35	1.4	1.9	1.7	1.45
3	1.55	1.5	1.3	1.35	1.2	2.7	2.3	2.3	1.35	1.9	1.7	1.4
4	1.55	1.5	1.3	1.3	1.2	2.6	2.5	2.25	1.4	1.8	1.75	1.4
5	1.55	1.5	1.3	1.3	1.25	2.6	2.6	2.25	1.4	1.8	1.75	1.45
6	1.55	1.3	1.3	1.3	1.25	2.7	2.5	2.2	1.35	1.8	1.75	1.45
7	1.55	1.35	1.2	1.3	1.2	2.7	2.5	2.2	1.3	1.9	1.7	1.5
8	1.4	1.35	1.25	1.3	1.2	2.4	2.5	2.15	1.2	1.9	1.7	1.5
9	1.4	1.5	1.25	1.3	1.25	2.4	2.5	2.1	1.2	1.9	1.7	1.55
10	1.5	1.5	1.25	1.2	1.25	2.6	2.4	2.3	1.2	2.0	1.7	1.55
11	1.5	1.5	1.3	1.3	1.9	2.6	2.2	2.4	1.2	2.3	1.75	1.55
12	1.5	1.5	1.2	1.3	1.9	2.7	2.0	2.2	1.2	2.2	1.7	1.55
13	1.5	1.5	1.3	1.2	2.0	2.8	1.95	2.2	1.2	2.0	1.7	1.5
14	1.5	1.5	1.3	1.2	2.0	2.7	1.8	2.15	1.2	1.95	1.7	1.4
15	1.45	1.5	1.3	1.2	2.05	2.75	1.7	2.1	1.3	1.9	1.7	1.4
16	1.45	2.1	1.2	1.2	2.1	2.9	1.6	2.15	1.35	1.8	1.7	1.35
17	1.4	1.35	1.25	1.3	2.2	2.9	1.75	2.0	1.3	1.8	1.65	1.35
18	1.4	1.3	1.3	1.3	2.1	2.8	1.75	2.25	1.3	1.8	1.60	1.35
19	1.4	1.3	1.3	1.3	2.1	2.8	1.7	2.1	1.35	1.9	1.6	1.4
20	1.4	1.35	1.5	1.3	2.1	2.75	1.7	1.8	1.4	1.9	1.6	1.4

[a] Given as 1.10, probably is 1.55. [b] Probably is 1.50.

Mean daily gage height, in feet, of Rock Creek near Round Valley, Cal., etc.—Cont'd.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1904.												
21	1.35	1.3	1.4	1.3	2.2	2.75	2.0	1.8	1.3	1.9	1.65	1.45
22	1.3	1.3	1.5	1.3	2.1	2.8	2.2	1.8	1.3	1.8	1.7	1.45
23	1.3	1.3	1.6	1.3	2.0	2.8	2.3	1.9	1.35	1.8	1.7	1.4
24	1.3	1.3	1.4	1.3	2.4	2.7	2.2	2.35	2.0	1.8	1.6	1.35
25	1.3	1.3	1.4	1.25	2.8	2.6	2.15	2.2	2.3	1.8	1.5	1.35
26	1.3	1.3	1.4	1.3	2.4	2.5	2.1	2.1	2.0	1.8	1.5	1.35
27	1.45	1.3	1.4	1.3	2.4	2.5	2.1	2.1	1.9	1.8	1.5	1.4
28	1.5	1.4	1.4	1.3	2.45	2.6	2.15	1.9	1.9	1.8	1.5	1.4
29	1.5	1.3	1.55	1.2	2.4	2.6	2.0	1.9	1.9	1.8	1.5	1.4
30	1.5	.....	1.4	1.2	2.4	2.5	2.0	1.8	1.9	1.75	1.5	1.5
31	1.5	.....	1.4	.....	2.4	.....	2.2	1.8	.....	1.75	.....	1.75

Rating table for Rock Creek near Round Valley, Cal., from August 4, 1903, to February 16, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.30	15	1.60	22	1.90	32	2.10	40
1.40	17	1.70	25	2.00	35	2.20	44
1.50	19	1.80	28				

Rating table for Rock Creek near Round Valley, Cal., from February 17 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.00	12	1.60	34	2.10	58	2.60	88
1.10	15	1.70	38	2.20	63	2.70	95
1.20	18	1.80	43	2.30	69	2.80	102
1.30	22	1.90	48	2.40	75	2.90	109
1.40	26	2.00	53	2.50	81	3.00	116
1.50	30						

Estimated monthly discharge of Rock Creek near Round Valley, Cal., for 1903 and 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
1903.				
August 4–31	25	17	20	1,111
September	22	15	18	1,071
October	17	15	15	922
November	19	17	18	1,071
December	22	18	20	1,230
The period				5,405
1904.				
January	20	15	17.4	1,070
February	40	15	20.5	1,179
March	34	18	23.6	1,451
April	22	18	21	1,250
May	102	18	50	3,074
June	109	75	91.7	5,456
July	88	34	60.5	3,720
August	75	43	59	3,628
September	69	18	29	1,726
October	69	41	47	2,890
November	41	30	36	2,142
December	40	24	27.7	1,703
The year	109	15	40.3	29,289

PINE CREEK NEAR ROUND VALLEY, CAL.

This station was established August 3, 1903, by J. C. Clausen and R. S. Hawley. It is located 150 feet below the wagon bridge on the road from Bishop to Long Valley and 100 feet above the mouth of the creek. The gage is a 1 by 3 inch vertical rod fastened in the rocks near the right bank. It is read once each day by Roscoe Jones. Discharge measurements are made by wading. The initial point for soundings is a stake on the right bank of the stream.

The channel is straight for about 50 feet above and for about 100 feet below the station. The current has a velocity of about 1 foot per second at ordinary stages. Both banks are high and rocky and are not liable to overflow. The bed of the stream is rocky and permanent. The bench mark is the one at the Rock Creek station. It is a point marked on the lava rock 15 feet east of the left end of the footbridge.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Pine Creek near Round Valley, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage. height.	Discharge.
1903.		*Feet.*	*Second-feet.*
August 3	R. S. Hawley	1.90	15.0
August 8	do	1.87	10.4
August 18	do	1.73	5.7
September 1	do	1.71	5.9
September 10	do	1.71	6.3
November 24	do	1.89	10.1
1904.			
April 27	R. S. Hawley	1.70	4.2
June 2	do	2.80	67
June 15	do	3.70	185
July 13	J. C. Clausen and L. M. Barnes	2.95	84
August 3	L. M. Barnes	2.70	58
September 9	R. S. Hawley	1.87	10.7
October 13	R. S. Hawley, W. B. Clapp, and R. J. Taylor.	2.30	31
November 12	R. J. Taylor	2.07	21
December 6	do	1.90	16

Mean daily gage height, in feet, of Pine Creek near Round Valley, Cal., for 1903 and 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
1									1.75	1.80	1.90	1.85
2									1.75	1.83	1.90	1.85
3									1.72	1.80	1.90	1.85
4								1.90	1.70	1.80	1.90	1.90
5								1.90	1.70	1.80	1.90	1.90
6								1.90	1.72	1.80	1.85	1.95
7								1.90	1.73	1.80	1.80	1.95
8								1.90	1.70	1.82	1.90	1.95
9								1.80	1.72	1.80	1.90	1.95
10								1.80	1.75	1.80	1.90	1.95
11								1.80	1.70	1.83	1.90	1.90
12								1.90	1.70	1.80	1.90	1.90
13								1.90	1.70	1.80	1.90	1.90
14								1.80	1.70	1.82	1.90	1.90
15								1.80	1.70	1.90	1.90	1.90
16								1.80	1.70	1.80	1.90	1.90
17								1.80	1.70	1.90	1.90	1.90
18								1.73	1.70	1.90	1.90	1.90
19								1.70	1.70	1.93	1.90	1.90
20								1.70	1.70	1.92	1.90	1.90
21								1.70	1.70	1.90	1.80	1.90
22								1.72	1.70	1.90	1.80	1.85
23								1.80	1.73	1.90	1.85	1.85

Mean daily gage height, in feet, of Pine Creek near Round Valley, Cal., etc.—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
24	.....	.....	.....	.....	.....	.....	.....	1.75	1.72	1.90	1.90	1.80
25	.....	.....	.....	.....	.....	.....	.....	1.80	1.70	1.90	1.90	1.85
26	.....	.....	.....	.....	.....	.....	.....	1.80	1.70	1.90	1.90	1.85
27	.....	.....	.....	.....	.....	.....	.....	1.75	1.70	1.90	1.85	1.90
28	.....	.....	.....	.....	.....	.....	.....	1.73	1.75	1.90	1.85	1.90
29	.....	.....	.....	.....	.....	.....	.....	1.70	1.80	1.90	1.85	1.90
30	.....	.....	.....	.....	.....	.....	.....	1.70	1.80	1.90	1.80	1.90
31	.....	.....	.....	.....	.....	.....	.....	1.70	.....	1.90	.....	1.90
1904.												
1	1.90	1.90	1.90	1.90	1.80	2.60	3.10	2.90	2.20	2.00	2.30	2.00
2	1.90	1.90	1.90	1.90	1.75	2.80	3.00	2.85	2.10	2.00	2.25	2.00
3	1.90	1.90	1.90	1.90	1.75	3.85	3.00	2.80	1.95	2.00	2.25	2.00
4	1.90	1.90	1.90	1.90	1.75	3.60	3.10	2.70	1.90	2.00	2.25	2.00
5	1.90	1.90	1.90	1.85	1.75	3.60	3.20	2.60	1.85	2.00	2.25	2.00
6	1.90	1.85	1.90	1.85	1.80	3.50	3.20	2.55	1.80	2.00	2.15	2.00
7	1.90	1.85	1.80	1.90	1.80	3.50	3.10	2.55	1.80	2.10	2.10	2.00
8	1.90	1.85	1.80	1.90	1.80	3.20	3.10	2.50	1.80	2.30	2.15	2.00
9	1.90	1.90	1.80	1.90	1.80	3.10	3.10	2.50	1.80	2.30	2.15	2.00
10	1.90	1.90	1.90	1.80	1.85	3.50	3.10	2.45	1.80	2.30	2.20	2.00
11	1.90	1.90	1.90	1.80	1.80	3.50	3.00	2.50	1.80	2.50	2.20	2.00
12	1.90	1.90	1.80	1.80	1.80	3.60	3.00	2.45	1.80	2.40	2.20	2.00
13	1.90	1.90	1.90	1.80	1.80	3.60	2.95	2.45	1.80	2.25	2.20	2.00
14	1.90	1.90	1.90	1.70	1.80	3.50	2.70	2.45	1.80	2.35	2.20	2.00
15	1.90	1.90	1.90	1.70	1.80	3.70	2.50	2.50	1.80	2.25	2.15	2.00
16	1.90	2.10	1.85	1.70	1.80	3.80	2.50	2.55	1.85	2.25	2.15	2.00
17	1.90	1.90	1.90	1.80	1.85	3.80	2.45	2.40	1.80	2.10	2.10	2.00
18	1.90	1.85	1.90	1.80	1.80	3.70	2.40	2.45	1.80	2.10	2.10	2.00
19	1.90	1.90	1.90	1.80	1.80	3.60	2.40	2.40	1.80	2.10	2.10	2.00
20	1.90	1.90	1.90	1.80	1.90	3.50	2.40	2.40	1.80	2.10	2.10	2.00
21	1.90	1.90	1.90	1.80	1.90	3.40	2.40	2.40	1.80	2.20	2.10	2.00
22	1.90	1.90	2.00	1.80	1.90	3.40	2.60	2.35	1.80	2.20	2.00	1.95
23	1.90	1.85	2.10	1.80	1.80	3.30	2.65	2.35	1.80	2.20	2.00	1.90
24	1.90	1.85	2.00	1.80	2.50	3.50	2.65	2.40	2.00	2.20	2.10	1.90
25	1.90	1.90	1.90	1.80	3.00	3.40	2.70	2.40	2.20	2.20	2.10	1.90
26	1.90	1.90	1.90	1.80	2.80	3.20	2.80	2.40	1.95	2.20	2.10	1.90
27	1.90	1.80	1.90	1.80	2.70	3.30	2.90	2.40	1.95	2.20	2.10	1.90
28	1.90	1.90	.....	1.80	2.60	3.30	2.80	2.25	1.90	2.25	2.10	1.95
29	1.90	1.90	1.90	1.80	2.70	3.40	2.65	2.25	1.90	2.25	2.00	2.00
30	1.90	.....	1.90	1.80	2.70	3.20	2.70	2.20	1.90	2.30	2.00	2.00
31	1.90	.....	1.90	.....	2.60	.....	2.85	2.20	.....	2.30	.....	2.30

Rating table for Pine Creek near Round Valley, Cal., from August 4, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.70	4	2.30	33	2.90	75	3.50	149
1.80	8	2.40	39	3.00	85	3.60	165
1.90	13	2.50	45	3.10	95	3.70	184
2.00	18	2.60	52	3.20	106	3.80	203
2.10	23	2.70	59	3.30	119	3.90	223
2.20	28	2.80	67	3.40	133		

Estimated monthly discharge of Pine Creek near Round Valley, Cal., for 1903 and 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
1903.				
August 4–31	13	4	7.9	439
September	8	4	4.7	280
October	14	8	10.8	664
November	13	8	11.8	702
December	16	8	12.6	775
The period				2,860
1904.				
January	13	13	13	799
February	23	8	12.4	713
March	23	8	12.9	793
April	13	5	9	536
May	85	6	21.7	1,334
June	213	52	142	8,450
July	106	39	70	4,304
August	75	28	44	2,705
September	28	8	12	714
October	45	18	28	1,722
November	33	18	25	1,488
December	33	13	17.5	1,076
The year	213	5	34	24,634

OWENS RIVER CANAL NEAR BISHOP, CAL.

This station was established August 5, 1903, by J. C. Clausen and R. S. Hawley. It is located at the footbridge near the quarter-section line which divides the north half of sec. 27, T. 6 S., R. 32 E., of the Mount Diablo meridian. The gage is a vertical rod nailed to the bridge. It is read once each day by A. S. Kinsley, the ditch tender. Discharge measurements are made from the footbridge to which the gage is attached. The initial point for soundings is on right bank of canals. The distances across stream are marked on the bridge at intervals of 2 feet. The channel is straight for 300 feet above and for 100 feet below the station. The current is sluggish. The right bank is high and rocky and will not overflow. The left bank is low and will overflow. The bed of the stream is composed of gravel and is permanent.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Owens River canal near Bishop, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
July 30	R. S. Hawley	.....	39.0
August 5	do	2.50	21.8
August 15	do	2.69	28.6
August 26	do	2.82	36.5
September 7	do	2.89	33.1
September 15	do	3.02	39.5
October 23	do	2.57	23.2
1904.			
February 3	R. S. Hawley	1.60	7.4
March 4	do	2.90	44
March 21	do	2.60	34
April 21	do	2.90	46
July 11	J. C. Clausen and L. M. Barnes	2.65	31
August 10	L. M. Barnes	2.80	40
September 5	R. S. Hawley	2.90	40
October 14	R. S. Hawley, W. B. Clapp, and R. J. Taylor.	1.65	6.1
November 1	R. J. Taylor	1.60	4.6

Mean daily gage height, in feet, of Owens River canal near Bishop, Cal., for 1903.

Day.	Aug.	Sept.	Oct.	Day.	Aug.	Sept.	Oct.	Day.	Aug.	Sept.	Oct.
1	.....	2.90	3.10	12	2.80	3.00	.....	22	2.85	3.00	.....
2	.....	2.90	3.10	13	2.80	3.05	.....	23	2.85	3.00	.....
3	.....	2.90	3.10	14	2.80	3.05	.....	24	2.85	3.00	.....
4	.....	2.95	3.10	15	(b)	3.05	.....	25	2.80	3.00	.....
5	a 2.50	2.95	3.10	16	(b)	3.05	.....	26	2.80	3.05	.....
6	2.50	(b)	3.10	17	2.75	3.05	.....	27	2.85	3.05	.....
7	2.50	2.95	3.10	18	2.80	3.05	.....	28	2.85	3.05	.....
8	(b)	2.90	3.10	19	(b)	3.10	.....	29	2.90	(b)	.....
9	2.70	2.90	3.10	20	2.80	3.10	.....	30	2.90	3.10	.....
10	2.75	2.95	2.70	21	(b)	(b)	.....	31	2.90	.....	.....
11	(b)	3.00	.....								

a Lowest water known in twenty-four years. b No record.

On October 10 the directors of the canal ordered part of the water turned off; irrigation was practically over for season. From October 10 no daily record was kept, but beginning October 11 the gage read about 1.60 until October 24; the water was then all turned out.

Mean daily gage height, in feet, of Owens River canal near Bishop, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	a 0.00	0.00	0.00	.....	.....	.....	.....	.....	.....
2	.00	1.6	.00	.....	2.9	.....	.....	.....	2.75
3	.00	1.6	.00	2.6	2.9	.....	.....	.....	.....
4	.00	.....	2.9	.....	2.9	.....	.....	2.65	.....
5	.00	.....	.....	.....	2.9	2.7	2.6	.....	28.
6	.00	.....	2.7	.....	2.9	.....	.....	2.8	2.95
7	.00	.....	.....	.....	2.9	2.7	2.6	.....	2.9
8	.00	.....	.....	2.7	.....	2.6	.....	.....	3.0
9	.00	.....	.....	.....	2.9	.....	.....	.....	3.0
10	.00	.....	.....	.....	2.9	.....	.....	.....	.....
11	.00	.....	.....	.....	2.9	.....	2.65	2.7	.....
12	.00	.....	.....	2.75	.....	.....	.....	.....	.....
13	.00	.....	.....	2.80	2.9	2.6	.....	.....	3.0
14	.00	.....	.....	2.85	.....	.....	.....	.....	.....
15	.00	.....	.....	2.85	.....	2.4	.....	2.7	.....
16	.00	a .00	.....	.....	2.9	.....	.....	.....	.....
17	.00	.00	.....	2.85	2.9	.....	.....	.....	3.05
18	.00	.00	.....	.....	2.9	.....	.....	.....	.....
19	.00	.00	.....	2.85	.....	.....	.....	.....	.....
20	.00	.00	.....	2.80	2.9	.....	.....	2.8	3.05
21	.00	.00	2.6	2.9	2.9	.....	.....	.....	(b)
22	.00	.00	.....	2.9	.....	2.6	.....	.....	.....
23	.00	.00	.....	.....	2.9	.....	.....	.....	.....
24	.00	.00	.....	2.9	2.9	.....	.....	.....	.....
25	.00	.00	.....	.....	2.9	.....	.....	2.8	.....
26	.00	.00	.....	2.9	.....	.....	2.7	.....	.....
27	.00	.00	.....	2.9	.....	2.5	2.75	.....	.....
28	.00	.00	.....	.....	.....	.....	.....	.....	.....
29	.00	.00	2.7	2.9	2.7	.....	.....	.....	.....
30	.00	.....	.....	.....	.....	.....	2.[illegible]	.....	.....
31	.00	.....	2.6	.....	.....	.....	.....	.....	.....

a Dry January 1 to February 1; February 16 to March 3.
b No record for remainder of the year.

Rating table for Owens River canal near Bishop, Cal., from January 1 to June 30, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.60	7	2.00	15	2.40	27	2.80	42
1.70	9	2.10	18	2.50	31	2.90	46
1.80	11	2.20	20	2.60	34	3.00	50
1.90	13	2.30	23	2.70	38	3.10	54

Rating table for Owens River canal near Bishop, Cal., from July 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.60	5	2.00	13	2.40	24	2.80	37
1.70	6	2.10	16	2.50	27	2.90	41
1.80	8	2.20	18	2.60	30	3.00	45
1.90	11	2.30	21	2.70	34		

Estimated monthly discharge of Owens River canal near Bishop, Cal., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
February	7	0	3.4	196
March	46	0	33	2,029
April	46	34	41.4	2,464
May	46	38	45	2,767
June	38	31	33.5	1,993
July	37	27	33	2,029
August	37	32	35	2,152
September 1–20	47	35	43	1,706
The period				15,336

NOTE.—Discharge interpolated for missing days.

BISHOP CREEK CANAL NEAR BISHOP, CAL.

This station was established August 5, 1903, by J. C. Clausen, assisted by R. S. Hawley. It is located at the footbridge below the waste gate near the house of the observer, A. Fitzgerald. It is 3½ miles northwest of Bishop, Cal. The gage is a 1 by 3 inch vertical rod fastened to the bridge anchor. Discharge measurements are made from the footbridge at which the gage is located. The initial point for soundings is on right bank; the initial point and points at which soundings are made are marked on footbridge. The channel is straight for 50 feet above and for 100 feet below this station. The current is swift. The right bank is high and the left bank is low. Neither bank is liable to overflow. The bed of the stream is composed of sand and gravel and is fairly permanent. The gaging stations on canals taking water from Owens River may be considered as temporary. The gage rods in most instances are securely fastened to the footbridges and are not likely to change. No permanent bench marks were established.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Bishop Creek canal near Bishop, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
July 30	R. S. Hawley		101
August 5	do	3.0	72
August 15	do	2.89	61
August 26	do	3.25	84
September 5	do	3.17	81
September 15	do	3.31	82
October 23	do	1.97	27
1904.			
February 11	R. S. Hawley	2.43	54
March 21	do	1.75	22
April 13	do	3.69	116
April 21	do	3.62	113
May 14	do	3.55	109
June 16	do	1.90	30
June 11	J. C. Clausen and L. M. Barnes	3.20	94
August 10	L. M. Barnes	2.00	26
September 5	R. S. Hawley	4.10	118

Mean daily gage height, in feet, of Bishop Creek canal near Bishop, Cal., for 1903.

Day.	Aug.	Sept.	Oct.	Day.	Aug.	Sept.	Oct.	Day.	Aug.	Sept.	Oct.
1				12				22	3.10	3.30	
2		3.15		13				23		3.30	
3		3.15		14	3.10			24		3.40	
4				15	2.90	3.30		25		3.40	
5	3.00	3.15		16		3.30		26	3.25	3.40	
6	3.10		2.00	17		3.25		27		3.40	
7				18	3.10	3.25		28		3.40	
8	3.10	3.30		19	3.00	3.30		29		(a)	
9				20		3.30		30			
10	3.10	3.30		21		3.30		31			
11	3.10										

[a] No record until October 6; but not much change in the canal.

NOTE.—On October 6 the head-gate was shut down, and until October 29, when the water was turned out, the gage read about 2.0 feet.

Mean daily gage height, in feet, of Bishop Creek canal near Bishop, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	[a] 0.00	0.00	0.00			3.5	2.6	3.8		[a] 0.00	0.00	0.00
2	.00	.00	.00			3.5	2.6	3.0				
3	.00	.00	.00		3.3	3.5	2.6	3.0				
4	.00	.00	.00	1.7	3.3	3.7		3.0				
5	.00	.00	.00		3.2	2.0	3.2	3.0	4.0			
6	.00	.00	.00	1.7	3.2	2.0	3.2	2.0	3.9			
7	.00	.00	.00	2.7	3.2	2.0	3.3	2.0	3.9			
8	.00	.00	.00	2.7	3.3	2.2	3.3	2.0	4.05			
9	.00	[a] .00	.00		3.3	2.2	3.3	2.0	4.0			
10	.00	2.45	.00	2.7	3.3			2.0	4.0			
11	.00		.00	2.7	3.3			2.1				
12	.00		.00	3.7		1.7	3.2	2.1	4.05			
13	.00	2.45	.00	3.7	3.8	1.7	3.2					
14	.00		.00		3.8	1.7	3.1	2.0	4.1			
15	.00		.00	3.7	3.8	1.7	3.1	3.3				
16	.00	2.45	.00	3.5	3.7	1.7	3.1	3.3	4.05			
17	.00		.00			1.7	3.6	3.3	4.05			
18	.00		.00	3.5	3.8	1.7	3.6	3.4				
19	.00	2.45	.00	3.6	3.7		3.6	3.35	4.1			
20	.00		[a] .00		3.7	1.8	3.6	3.35	3.4			
21	.00		1.75		3.7	1.8	3.6		3.4			
22	.00			3.6	3.7	1.8	3.6	3.7	3.4			
23	.00	2.45		3.3	3.7	1.8	3.6	3.7	3.4			
24	.00	[a] .00			3.3	1.8		3.7	3.45			
25	.00	.00		3.3	3.3	1.8	3.7					
26	.00	.00		3.3	3.3		3.7					
27	.00	.00		3.3	3.3	2.6	3.7					
28	.00	.00		3.6	3.2	2.6	3.7					
29	.00	.00		3.6	3.2	2.6	3.7					
30	.00			3.6	3.2	2.6	3.8		3.9			
31	.00						3.8					[a] .00

[a] Canal dry: January 1 to February 9, February 24 to March 20; October 1 to December 31.

Rating table for Bishop Creek canal near Bishop, Cal., from February 1 to October 1, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.60	15	2.30	48	3.00	81	3.70	116
1.70	20	2.40	53	3.10	86	3.80	121
1.80	24	2.50	57	3.20	91	3.90	126
1.90	28	2.60	62	3.30	96	4.00	131
2.00	33	2.70	67	3.40	101	4.10	136
2.10	38	2.80	72	3.50	106	4.20	141
2.20	43	2.90	76	3.60	111		

Estimated monthly discharge of Bishop Creek canal near Bishop, Cal., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
February	55	0	26.5	1,524
March	22	0	7.8	480
April	116	20	83.1	4,945
May	121	91	103.4	6,359
June	106	20	42.1	2,505
July	121	62	99	6,087
August	126	33	85	5,226
September	136	101	123	7,319
The period				34,445

NOTE.—Discharge interpolated for missing days.

FARMERS' CANAL NEAR BISHOP, CAL.

This station was established August 6, 1903, by J. C. Clausen and R. S. Hawley. It is located at the footbridge near the house of the observer, Robert Love, and 3 miles north of Bishop, Cal. The gage is a 1 by 3 inch vertical rod fastened to the bridge pier. Discharge measurements are made from the footbridge, to which the gage is attached. The initial point for soundings is on footbridge, near the right bank. The distances across stream are marked every 2 feet on the footbridge.

The channel is straight for 300 feet above and for 50 feet below the station. The current is sluggish. Both banks are low and are liable to overflow. The bed of the stream is sandy and shifting.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Farmers' canal near Bishop, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
July 31	R. S. Hawley	.....	13.9
August 6	do	2.4	7.0
August 17	do	2.7	14.2
August 25	do	2.5	10.7
September 3	do	2.42	9.7
September 14	do	2.58	10.4
October 23	do	2.55	16.2
November 27	do	[a] 2.54	16.0
1904.			
February 3	R. S. Hawley	2.55	15.5
April 2	do	2.35	11.3
April 20	do	2.60	17.0
May 14	do	2.83	27.0
June 16	do	3.02	22.0
July 11	J. C. Clausen and L. M. Barnes	2.55	15.0
July 30	L. M. Barnes	3.05	24.0
August 25	do	3.05	26.0
September 6	R. S. Hawley	2.80	21.0
October 14	R. S. Hawley, W. B. Clapp, and R. J. Taylor	2.41	8.1
November 1	R. J. Taylor	2.40	8.1
December 1	do	2.30	7.2

[a] Corrected gage height.

Mean daily gage height, in feet, of Farmers' canal near Bishop, Cal., for 1903 and 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
1	.....	.....	.....	.....	.....	.....	.....	.....	2.40	2.95	2.55	2.50
2	.....	.....	.....	.....	.....	.....	.....	.....	2.40	2.95	.....	.....
3	.....	.....	.....	.....	.....	.....	.....	.....	2.43	2.95	2.55	2.50
4	.....	.....	.....	.....	.....	.....	.....	.....	2.40	3.00	.....	.....
5	.....	.....	.....	.....	.....	.....	.....	.....	2.45	3.03	2.55	2.50
6	.....	.....	.....	.....	.....	.....	.....	.....	2.45	.....	.....	.....
7	.....	.....	.....	.....	.....	.....	.....	2.40	2.50	3.05	2.55	2.50
8	.....	.....	.....	.....	.....	.....	.....	2.33	2.58	.....	2.55	.....
9	.....	.....	.....	.....	.....	.....	.....	2.40	2.67	2.82	(2.55)	2.50
10	.....	.....	.....	.....	.....	.....	.....	2.60	2.65	.....	(2.55)	.....
11	.....	.....	.....	.....	.....	.....	.....	2.60	.....	2.80	(2.55)	2.50
12	.....	.....	.....	.....	.....	.....	.....	2.67	2.68	.....	(2.55)	.....
13	.....	.....	.....	.....	.....	.....	.....	2.75	2.57	2.80	(2.55)	2.50
14	.....	.....	.....	.....	.....	.....	.....	.....	2.60	.....	2.55	.....
15	.....	.....	.....	.....	.....	.....	.....	.....	2.60	.....	2.55	2.48
16	.....	.....	.....	.....	.....	.....	.....	2.70	2.63	2.90	(2.55)	.....
17	.....	.....	.....	.....	.....	.....	.....	2.70	.....	[a] 2.50	(2.55)	2.50

[a] The rock dam below the gage rod was partly removed.

Mean daily gage height, in feet, of Farmers' canal near Bishop, Cal., etc.—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
18								2.68	2.67		(2.55)	
19									2.80	2.60	(2.55)	2.45
20								2.50	2.82	2.50	(2.55)	
21									2.85	2.50	2.55	2.50
22								2.50	2.83	2.50	2.55	
23								2.50		2.55	(2.55)	2.48
24								2.55	2.87		(2.55)	
25								2.50			(2.55)	2.50
26								2.50	2.90	2.53	(2.55)	
27								2.55	2.93		(2.55)	2.50
28								2.50	2.90		2.55	
29										2.55		2.50
30								2.45	2.92			
31												2.50
1904.												
1		2.55	2.3			2.65	2.65	3.00	3.00	2.50	2.40	2.30
2	2.5			2.35	2.3				3.10			
3		2.55		2.5	2.1	2.75	2.60	3.05	3.05	2.45	2.35	
4	2.5						2.60					
5					2.4	2.75		3.10		2.50		
6	2.5	2.55			2.5		2.55		2.80			2.30
7		2.5		2.3				3.05	2.80	2.55		
8							2.55		2.75		2.30	
9	2.5							3.10		2.45		2.30
10				2.3		3.05			2.70			
11	2.5				2.6		2.60	3.05		2.45	2.30	
12				2.3					2.70			
13	2.5				2.6	3.10	2.55	3.10	2.75	2.40		2.25
14												
15				2.3	2.65		2.50	3.10	2.70	2.40	2.30	
16	2.55				2.85							2.25
17						3.1	2.70	3.10	2.75			
18	2.5				2.95				2.80	2.40	2.25	
19				2.3				3.05				
20				2.6	2.75	3.0			2.90			2.30
21	2.5								2.95	2.35		
22				2.9				3.10			2.30	
23	2.55				2.65			3.15	3.00			2.30
24												
25				2.0	2.6			3.05		2.40	2.30	
26	2.55								3.10			
27				1.9					2.70			2.20
28				0	2.65				2.60	2.40		
29	2.55			0		2.6						
30				0	2.70	2.9	3.05	3.10	2.60			
31								3.10				2.15

NOTE.—Gage heights in parenthesis are estimated.

Rating table for Farmers' canal near Bishop, Cal., from January 1 to May 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.00	4	2.30	10	2.60	18	2.90	30
2.10	6	2.40	12	2.70	21	3.00	35
2.20	8	2.50	15	2.80	25	3.10	40

Rating table for Farmers' canal near Bishop, Cal., from June 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.10	3	2.40	8	2.70	15	3.00	23
2.20	5	2.50	10	2.80	18	3.10	26
2.30	6	2.60	13	2.90	21	3.20	29

Estimated monthly discharge of Farmers' canal near Bishop, Cal., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January	16	15	15.3	941
February	16	15	15.2	874
March	10	10	10	615
April	30	0	10.2	607
May	32	6	18.8	1,156
June	26	13	21	1,250
July	25	10	16	984
August	28	23	26	1,599
September	26	13	19	1,131
October	12	7	9	553
November	8	6	6	357
December	6	4	5.7	350
The year	32	0	14.4	10,417

NOTE.—Discharge interpolated for missing days.

M'NALLY CANAL NEAR BISHOP, CAL.

This station was established July 31, 1903, by J. C. Clausen and R. S. Hawley. It is located at the head of the canal, 3¾ miles north of Bishop, Cal. The gage is a 1 by 3 inch vertical board fastened to the headworks of the canal. Discharge measurements are made from a footbridge. The initial point for soundings is marked on the footbridge near the right bank. The channel is straight for 50 feet below

the gage. The current is swift. Both banks are high and will not overflow. The bed of the stream is rocky and permanent.

No gage reader could be obtained for this station, but since the gage was installed there has been little variation in the amount of water flowing in the canal.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of McNally canal near Bishop, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
July 31	R. S. Hawley	1.40	66
August 6	do	1.40	66
August 17	do	1.36	63
August 25	do	1.25	54
September 4	do	1.25	52
September 14	do	1.26	52
September 21	do	1.10	40
1904.			
April 2	R. S. Hawley	.80	29
April 20	do	1.37	68
May 14	do	1.52	83
July 11	J. C. Clausen and L. M. Barnes	1.55	81
July 30	L. M. Barnes	1.90	81
August 25	do	1.70	50
September 5	R. S. Hawley	1.75	46

Mean daily gage height, in feet, of McNally canal near Bishop, Cal., for 1904. [a]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Oct.	Nov.	Dec.
1	[b]0.00	0.00	0.00			1.50	1.60	0.00	0.00	0.00
2	.00	.00	.00	0.80				.00	.00	.00
3	.00	.00	.00			1.80		.00	.00	.00
4	.00	.00	.00					.00	.00	.00
5	.00	.00	.00					.00	.00	.00
6	.00	.00	.00			1.70		.00	.00	.00
7	.00	.00	.00			1.50		.00	.00	.00
8	.00	.00	.00	.90				.00	.00	.00
9	.00	.00	.00			1.70		.00	.00	.00
10	.00	.00	.00					.00	.00	.00
11	.00	.00	.00			1.30	1.55	.00	.00	.00
12	.00	.00	.00			1.50		.00	.00	.00
13	.00	.00	.00				1.90	.00	.00	.00
14	.00	.00	.00		1.52	1.60		.00	.00	.00
15	.00	.00	.00			1.50	1.80	.00	.00	.00

[a] Dry: January, February, March, October, November, and December.
[b] No record: August and September.

Mean daily gage height, in feet, of McNally canal near Bishop, Cal., etc.—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Oct.	Nov.	Dec.
16	0.00	0.00	0.00	.....	.....	.....	1.90	0.00	0.00	0.00
17	.00	.00	.00	.....	.....	.....	2.00	.00	.00	.00
18	.00	.00	.00	.....	.....	.....	2.10	.00	.00	.60
19	.00	.00	.00	.....	.....	.....	.....	.00	.00	.00
20	.00	.00	.00	1.35	.....	.....	.....	.00	.00	.00
21	.00	.00	.00	.....	.....	.....	.....	.00	.00	.00
22	.00	.00	.00	.....	.....	.....	.....	.00	.00	.00
23	.00	.00	.00	.....	.....	.....	.....	.00	.00	.00
24	.00	.00	.00	.....	.....	.....	.....	.00	.00	.00
25	.00	.00	.00	.....	.....	.....	.....	.00	.00	.00
26	.00	.00	.00	.....	.....	1.40	.....	.00	.00	.00
27	.00	.00	.00	.....	.....	.....	.....	.00	.00	.00
28	.00	.00	.00	.....	.....	.....	.....	.00	.00	.00
29	.00	.00	.00	.....	.....	.....	.....	.00	.00	.00
30	.00	.....	.00	.....	.....	.....	1.90	.00	.00	.00
31	.00	.....	.00	.....	.....	.....	.....	.00	.....	.00

Rating table for McNally canal near Bishop, Cal., from April 1 to July 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.70	22	1.10	50	1.50	78	1.90	106
.80	29	1.20	57	1.60	85	2.00	113
.90	36	1.30	64	1.70	92	2.10	120
1.00	43	1.40	71	1.80	99		

Rating table for McNally canal near Bishop, Cal., from August 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.40	10	1.60	30	1.80	62
1.50	20	1.70	45	1.90	82

Estimated monthly discharge of McNally canal near Bishop, Cal., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April	68	29	50.6	3,007
May	.....	.....	80	4,919
June	99	64	80	4,760
July	120	83	100	6,148
The period	.....	.....	.....	18,834

NOTE.—Discharge interpolated for missing days.

GEORGE COLLINS'S CANAL NEAR BISHOP, CAL.

This station was established August 17, 1903, by R. S. Hawley. It is located at the footbridge 3 miles east and one-half mile north of Bishop, Cal. The gage is a vertical rod fastened to the bridge near the house of Arthur Wines, the observer. Discharge measurements are made from the bridge. The initial point for soundings is marked on the footbridge near the right bank of the canal. The channel is straight for 75 feet above and for 50 feet below the station. The current is sluggish. The right bank is low and the left bank is high. Neither bank is liable to overflow. The bed of the stream is composed of sand and is fairly permanent.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of George Collins's canal near Bishop, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
July 31	R. S. Hawley		4.9
August 11	do		5.6
August 17	do	1.00	6.3
August 27	do	1.01	6.0
September 7	do	.94	5.5
September 14	do	.98	5.5
October 23	do	.60	2.8
1904.			
February 4	R. S. Hawley	.30	1.5
April 2	do	1.20	11.1
April 14	do	.70	4.2
June 8	do	1.58	14.0
July 12	J. C. Clausen and L. M. Barnes	1.50	9.6
August 6	L. M. Barnes	1.50	9.7
August 20	do	1.55	9.3
October 10	R. S. Hawley and R. J. Taylor	1.03	1.8
November 1	R. J. Taylor	.80	.7

Mean daily gage height, in feet, of George Collins's canal near Bishop, Cal., for 1903 and 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
1									1.03	0.95	0.75	0.75
2									.98	.95	.75	.75
3									.97	.95	.75	.75
4									.98	.95	.75	.75
5									.97	.95	.75	.70
6									.98	.95	.70	.65
7									.97	.95	.70	.65
8									.95	.95	.70	.65
9									.95	.95	.70	.65
10									.95	.95	.70	.65
11									.95	.95	.75	.65
12									.92	[a] .80	.75	.65
13									.93	.80	.75	.63
14									.95	.80	.75	.62
15									.95	.80	.75	.63
16								1.00	.95	.80	.75	.62
17								.98	.95	.80	[b] .50	.63
18								.92	.97	.80	.50	.60
19								.93	.95	.80	.50	.60
20								.92	1.35	.80	.50	.60
21								.70	1.35	.85	.55	([c])
22								.73	1.35	.85	.55	
23								.70	1.35	[d] .75	.55	
24								.90	1.35	.75	.55	
25								.90	1.35	.75	.55	
26								.90	1.35	.75	.55	
27								.97	1.35	.75	.62	
28								1.03	1.20	.75	.70	
29								1.02	1.20	.75	.70	
30								1.03	1.20	.75	.85	
31								1.04		.75		
1904.												
1	[e] 0.00	0.00	0.2	1.3	0.6	1.5	1.3	1.5	1.55	1.0		
2	.00	.00	.2	1.3	.6	1.5	1.3					
3	.00	.00	.2	1.3	.6	1.5	1.3	1.5	1.49	1.3		
4	.00	.00	.2	1.2	.6	1.6			1.1	1.3		
5	.00	.00	.2	1.2	.6		1.3					
6	.00	.00	.2	1.2	.7			1.5	.5	1.6		
7	.00	.00	[e] .00	1.2	.7		1.4					
8	.00	.00	.00	1.2	.6	1.6	1.4	1.3	1.0			
9	.00	.00	.00	.9	.6		1.4		1.4			
10	.00	.00	.00	.9	.8	1.6		1.5				
11	.00	.2	.00	.9	.8	1.6	1.4		1.5	.7		
12	.00	.2	.00	.9	1.1	1.5		1.5				
13	.00	.2	.00	.7	1.3	1.6	1.35		1.5	.6		
14	.00	.2	.00	.7	1.3			1.5				
15	.00	.2	.00	.7	1.6	1.5	1.3		1.3			
16	.00	.3	.00	.7	1.6			1.5	1.1	1.0		
17	.00	.6	.2	.8	1.6	1.6	1.3		1.1	.9		
18	.00	.3	.3	.8	1.6			1.6	1.4	.6		

[a] Falling slowly; no storms.
[b] Falling fast.
[c] Canal turned off.
[d] Falling slightly.
[e] Dry: January 1 to February 10; March 7-16; March 21-22.

Mean daily gage height, in feet, of George Collins's canal near Bishop, Cal., etc.—Cont'd.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1904.												
19	0.00	0.2	0.2	0.9	1.6	1.5	1.2	.....	.....	.....	.....	.....
20	.00	.2	.2	1.0	1.6	.....	.....	1.5	1.4	.....	.....	.....
21	.00	.2	[a] .00	1.0	1.6	1.6	.8	.....	1.4	(b)	.....	.....
22	.00	.3	.00	1.0	1.5	.....	.....	1.5	.....	.....	.....	.....
23	.00	.3	.5	1.1	1.4	1.5	1.2	.....	1.5	.....	.....	.....
24	.00	.6	.3	1.1	1.5	.....	.....	1.55	.....	.....	.....	.....
25	.00	.5	.3	1.2	1.5	1.5	1.5	.....	.....	.....	.....	.....
26	.00	.5	1.4	1.1	1.5	1.5	.....	1.5	.....	.....	.....	.....
27	.00	.3	1.43	1.1	1.6	1.5	1.5	.....	.....	.....	.....	.....
28	.00	.4	1.4	1.0	1.6	1.4	.....	.....	.....	.....	.....	.....
29	.00	.4	1.4	.8	1.6	1.4	1.55	1.5	.....	.....	.....	.....
30	.00	.....	1.4	.6	1.6	1.3	1.5	.....	1.2	.....	.....	.....
31	.00	.....	1.3	.....	1.6	.....	1.5	1.55	.....	.....	.....	.....

[a] Dry: January 1 to February 10; March 7-16; March 21-22.
[b] Water shut off for remainder of year.

Rating table for George Collins's canal near Bishop, Cal., from January 1 to June 30, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.30	1	0.70	5	1.10	9	1.40	12
.40	2	.80	6	1.20	10	1.50	13
.50	3	.90	7	1.30	11	1.60	15
.60	4	1.00	8				

Rating table for George Collins's canal near Bishop, Cal., from July 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.80	0	1.10	3	1.30	6	1.50	9
.90	1	1.20	4	1.40	7	1.60	11
1.00	2						

Estimated monthly discharge of George Collins's canal near Bishop, Cal., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
February	4	0	1.1	63
March	12	0	2.7	166
April	11	4	7.9	470
May	15	4	10.5	646
June	15	12	13.7	815
July	10	0	6	369
August	11	6	9	553
September	13	0	6	357
October 1-20	11	0	3	119
The period				3,558

NOTE.—Discharge interpolated for missing days.

BISHOP CREEK NEAR BISHOP, CAL.

This station was established August 10, 1903, by J. C. Clausen and R. S. Hawley. It is located at the wagon bridge on the Bishop road, about 4¼ miles from Bishop and about 2 miles from the point where the creek leaves the canyon. North Hillside canal, South Hillside canal, and Powers canal are taken out above the station. The gage is a 1 by 3 inch vertical rod fastened in the rocks and braced to the right bank just above the wagon bridge. It is read once each day by A. S. Kilpatrick. Discharge measurements are made from the wagon bridge. The initial point for soundings is marked on the bridge near the right bank of the stream. The channel is straight for 100 feet above and for 50 feet below the station. The current is swift. Both banks are high and rocky and are not liable to overflow. The bed of the stream is rough and rocky and is permanent. The bench mark is a large flat granite bowlder on the right bank, 40 feet above the bridge.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Bishop Creek near Bishop, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
August 9	R. S. Hawley	2.45	121
August 19	do	2.17	95
August 25	do	2.20	96
September 3	do	1.99	[a]67
September 7	do	1.80	52
September 15	do	1.65	40
September 21	do	1.60	38
October 24	do	1.39	27
November 20	do	1.41	26
December 26	do	1.35	25
1904.			
January 23	R. S. Hawley	1.40	30
February 20	do	1.50	33
March 14	do	1.65	42
April 8	E. C. Murphy, S. G. Bennett, and R. S. Hawley	1.60	34
April 25	R. S. Hawley	2.05	75
April 30	do	2.00	67
May 17	do	2.95	180
June 8	do	3.65	342
July 12	J. C. Clausen and L. M. Barnes	3.00	197
August 8	L. M. Barnes	3.30	240
September 7	R. S. Hawley	2.10	74
October 15	R. S. Hawley, W. B. Clapp, and R. J. Taylor	2.30	95
November 9	R. J. Taylor	1.75	49
December 5	do	1.39	20

[a] Corrected discharge.

Mean daily gage height, in feet, of Bishop Creek near Bishop, Cal., for 1903 and 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
1									2.00	1.60	1.45	1.30
2									1.95	1.60	1.45	1.30
3									1.90	1.70	1.45	1.30
4									2.00	1.70	1.45	1.35
5									2.00	1.70	1.45	1.35
6									2.00	1.70	1.45	1.35
7									2.00	1.70	1.45	1.40
8									1.90	1.70	1.45	1.40
9									1.90	1.70	1.45	1.40
10									1.80	1.70	1.45	1.40
11								2.50	1.80	1.70	1.45	1.40

Mean daily gage height, in feet, of Bishop Creek near Bishop, Cal., etc.—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
12	.....	.....	.....	.....	.....	.....	.....	2.50	1.75	1.70	1.45	1.40
13	.....	.....	.....	.....	.....	.....	.....	2.50	1.75	1.70	1.45	1.40
14	.....	.....	.....	.....	.....	.....	.....	2.40	1.70	1.70	1.45	1.40
15	.....	.....	.....	.....	.....	.....	.....	2.30	1.70	1.65	1.45	1.40
16	.....	.....	.....	.....	.....	.....	.....	2.30	1.65	1.65	1.45	1.45
17	.....	.....	.....	.....	.....	.....	.....	2.30	1.60	1.70	1.40	1.45
18	.....	.....	.....	.....	.....	.....	.....	2.20	1.60	1.65	1.40	1.45
19	.....	.....	.....	.....	.....	.....	.....	2.20	1.60	1.50	1.40	1.45
20	.....	.....	.....	.....	.....	.....	.....	2.50	1.60	1.50	1.40	1.45
21	.....	.....	.....	.....	.....	.....	.....	2.20	1.60	1.45	1.40	1.45
22	.....	.....	.....	.....	.....	.....	.....	2.20	1.70	1.45	1.40	1.45
23	.....	.....	.....	.....	.....	.....	.....	2.25	1.60	1.45	1.40	1.45
24	.....	.....	.....	.....	.....	.....	.....	2.20	1.60	1.45	1.40	1.45
25	.....	.....	.....	.....	.....	.....	.....	2.15	1.60	1.45	1.40	1.45
26	.....	.....	.....	.....	.....	.....	.....	2.15	1.65	1.45	1.40	1.45
27	.....	.....	.....	.....	.....	.....	.....	2.10	1.60	1.45	1.40	1.40
28	.....	.....	.....	.....	.....	.....	.....	2.05	1.60	1.45	1.40	1.40
29	.....	.....	.....	.....	.....	.....	.....	2.05	1.70	1.45	1.40	1.40
30	.....	.....	.....	.....	.....	.....	.....	2.05	1.65	1.45	1.40	1.40
31	.....	.....	.....	.....	.....	.....	.....	2.00	.....	1.45	.....	1.40
1904.												
1	1.4	1.4	1.6	1.6	2.0	3.2	3.3	3.7	2.1	2.1	1.9	1.5
2	1.4	1.4	1.6	1.6	2.0	3.3	3.3	3.6	2.1	2.2	1.9	1.5
3	1.4	1.4	1.6	1.6	2.0	3.7	3.1	3.5	2.1	2.4	1.8	1.5
4	1.4	1.4	1.6	1.6	2.0	3.8	3.1	3.5	2.1	2.4	1.8	1.45
5	1.4	1.5	1.6	1.6	2.0	3.9	3.2	3.5	2.1	2.4	1.8	1.45
6	1.4	1.5	1.6	1.6	2.0	3.8	3.2	3.6	2.0	2.3	1.85	1.4
7	1.4	1.5	1.6	1.5	2.1	3.7	3.15	3.7	1.95	2.2	1.8	1.4
8	1.4	1.5	1.6	1.6	2.1	3.6	3.1	3.8	1.95	2.2	1.75	1.45
9	1.4	1.5	1.6	1.7	2.1	3.6	3.1	3.7	1.9	2.2	1.7	1.45
10	1.4	1.5	1.6	1.7	2.2	3.6	3.1	3.7	1.9	2.15	1.65	1.5
11	1.4	1.5	1.7	1.7	2.4	3.7	3.0	3.6	1.85	2.15	1.65	1.5
12	1.4	1.5	1.7	1.7	2.5	3.7	2.9	3.2	1.85	2.1	1.6	1.45
13	1.4	1.5	1.7	1.7	2.6	3.8	2.9	3.0	1.85	2.1	1.6	1.45
14	1.4	1.5	1.7	1.7	2.8	3.9	2.9	2.9	1.85	2.05	1.6	1.45
15	1.4	1.5	1.7	1.8	2.8	4.0	2.8	2.9	1.8	2.0	1.6	1.45
16	1.4	1.5	1.7	1.8	2.8	4.1	2.8	2.8	1.8	2.0	1.55	1.5
17	1.4	1.5	1.6	1.8	2.9	4.1	2.8	2.7	1.8	2.0	1.55	1.5
18	1.4	1.5	1.6	1.8	2.9	4.1	2.8	2.7	1.8	1.95	1.5	1.45
19	1.4	1.5	1.6	1.8	2.8	4.1	2.8	2.6	1.8	1.95	1.5	1.4
20	1.4	1.5	1.6	1.7	2.8	4.0	3.0	2.6	1.8	1.95	1.5	1.4
21	1.4	1.5	1.5	1.6	2.9	4.0	3.2	2.6	1.85	1.9	1.5	1.4
22	1.4	1.5	1.5	1.8	2.9	3.9	3.2	2.7	1.85	1.9	1.5	1.4
23	1.4	1.5	1.6	2.1	2.9	3.9	3.1	2.7	1.9	1.95	1.5	1.4
24	1.4	1.5	1.6	2.4	3.0	3.7	3.2	2.6	1.9	1.95	1.5	1.4
25	1.4	1.5	1.9	2.3	3.0	3.7	3.5	2.5	2.0	2.0	1.5	1.4
26	1.4	1.5	1.8	2.3	3.2	3.7	3.5	2.4	1.9	2.0	1.5	1.35
27	1.4	1.5	1.7	2.2	3.1	3.5	3.5	2.5	1.85	2.0	1.5	1.35
28	1.4	1.6	1.8	2.1	3.1	3.4	3.5	2.5	1.9	1.9	1.5	1.4
29	1.4	1.6	1.7	2.0	3.1	3.4	3.5	2.3	2.0	1.85	1.5	1.4
30	1.4	.....	1.6	2.0	3.1	3.4	3.6	2.1	2.1	1.95	1.5	1.4
31	1.4	.....	1.6	.....	3.2	.....	3.7	2.1	.....	1.9	.....	1.4

Rating table for Bishop Creek near Bishop, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.30	22	2.10	80	2.90	183	3.60	327
1.40	27	2.20	90	3.00	200	3.70	355
1.50	32	2.30	101	3.10	218	3.80	386
1.60	39	2.40	113	3.20	237	3.90	417
1.70	46	2.50	125	3.30	257	4.00	448
1.80	54	2.60	138	3.40	279	4.10	479
1.90	62	2.70	152	3.50	302	4.20	510
2.00	71	2.80	167				

Estimated monthly discharge of Bishop Creek near Bishop, Cal., for 1903 and 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
1903.				
August 11–31	125	71	95.8	3,990
September	71	39	50.5	3,005
October	46	30	38.6	2,373
November	30	27	28.6	1,702
December	30	22	27.3	1,679
The period				12,749
1904.				
January	27	27	27	1,660
February	39	27	31.8	1,829
March	62	32	42	2,582
April	113	32	56.6	3,366
May	237	71	149.3	9,180
June	479	237	372.8	22,183
July	355	167	233	14,327
August	386	80	212	13,035
September	80	54	64	3,808
October	113	58	78	4,796
November	62	32	41	2,440
December	32	24	29	1,783
The year	479	24	111	80,989

RAWSON CANAL NEAR BISHOP, CAL.

This station was established August 7, 1903, by R. S. Hawley. It is located at the county bridge 2¼ miles east of Bishop, Cal. The gage is a vertical rod fastened to the bridge from which discharge measurements are made. The gage is read once each day by Paul McDonald. The initial point for soundings is marked on the bridge near the right bank of the canal. The channel is straight for 100 feet above and below the station and the current is swift. The right bank is high and the left bank is low. Neither bank is liable to overflow. The bed of the stream is composed of gravel and is permanent.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Rawson canal near Bishop, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
July 31	R. S. Hawley		17.0
August 7	do	1.70	17.6
August 11	do	1.62	13.6
August 17	do	1.85	20.3
August 27	do	1.73	17.1
September 7	do	1.77	18.2
September 14	do	1.81	17.1
October 24	do	1.73	15.4
November 27	do	1.60	13.0
1904.			
February 4	R. S. Hawley	1.66	16.6
February 11	do	2.01	35
April 2	do	1.50	9.4
April 14	do	1.87	27
June 8	do	1.96	24
July 12	J. C. Clausen and L. M. Barnes	1.75	18.8
August 6	L. M. Barnes	1.80	21
August 20	do	2.23	31

Mean daily gage height, in feet, of Rawson canal near Bishop, Cal., for 1903 and 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
1	.....	.....	.....	.....	.....	.....	.....	.....	1.74	2.00	1.59	1.65
2	.....	.....	.....	.....	.....	.....	.....	.....	1.72	2.00	1.63	1.64
3	.....	.....	.....	.....	.....	.....	.....	.....	1.76	1.96	1.60	1.70
4	.....	.....	.....	.....	.....	.....	.....	.....	1.73	1.93	1.60	1.71
5	.....	.....	.....	.....	.....	.....	.....	.....	1.74	1.93	1.60	1.70
6	.....	.....	.....	.....	.....	.....	.....	.....	1.80	1.94	1.63	1.35
7	.....	.....	.....	.....	.....	.....	.....	.....	1.79	1.91	1.63	1.35
8	.....	.....	.....	.....	.....	.....	.....	.....	1.80	1.92	1.63	1.43
9	.....	.....	.....	.....	.....	.....	.....	.....	1.76	2.01	1.65	1.35
10	.....	.....	.....	.....	.....	.....	.....	.....	1.78	2.01	1.66	1.30
11	.....	.....	.....	.....	.....	.....	.....	1.60	1.77	1.80	1.65	1.30
12	.....	.....	.....	.....	.....	.....	.....	1.80	1.85	1.75	1.61	1.30
13	.....	.....	.....	.....	.....	.....	.....	1.90	1.90	1.75	1.63	1.39
14	.....	.....	.....	.....	.....	.....	.....	1.90	1.72	1.70	1.60	1.30
15	.....	.....	.....	.....	.....	.....	.....	1.85	1.80	1.70	1.70	1.42
16	.....	.....	.....	.....	.....	.....	.....	1.80	1.85	1.70	1.80	1.44
17	.....	.....	.....	.....	.....	.....	.....	1.85	1.93	1.65	1.92	1.45
18	.....	.....	.....	.....	.....	.....	.....	1.82	1.94	1.65	1.92	1.10
19	.....	.....	.....	.....	.....	.....	.....	1.81	1.99	1.80	1.93	1.10
20	.....	.....	.....	.....	.....	.....	.....	1.86	2.10	1.75	1.90	1.10
21	.....	.....	.....	.....	.....	.....	.....	1.84	2.10	1.70	1.90	1.10
22	.....	.....	.....	.....	.....	.....	.....	1.82	1.94	1.65	1.90	1.20
23	.....	.....	.....	.....	.....	.....	.....	1.81	1.92	1.70	1.91	1.10
24	.....	.....	.....	.....	.....	.....	.....	1.80	1.93	1.73	1.90	1.10
25	.....	.....	.....	.....	.....	.....	.....	1.75	1.94	1.75	1.90	1.10
26	.....	.....	.....	.....	.....	.....	.....	1.74	2.04	1.76	1.90	1.30
27	.....	.....	.....	.....	.....	.....	.....	1.74	2.00	1.77	1.53	1.30
28	.....	.....	.....	.....	.....	.....	.....	1.76	2.00	1.63	1.50	1.30
29	.....	.....	.....	.....	.....	.....	.....	1.73	2.01	1.59	1.51	1.30
30	.....	.....	.....	.....	.....	.....	.....	1.74	2.00	1.59	1.65	1.30
31	.....	.....	.....	.....	.....	.....	.....	1.72	.....	1.59	.....	1.30
1904												
1	[a] 0.00	0.00	1.7	1.5	1.9	2.1	1.9	1.8	2.25	.00	.00	.00
2	.00	.00	1.7	1.5	1.9	1.9	1.9	1.8	2.2	.00	.00	.00
3	.00	1.65	1.7	1.5	1.85	1.9	1.8	1.8	2.1	.00	.00	.00
4	.00	1.65	1.7	1.5	1.85	1.9	1.8	1.8	2.1	.00	.00	.00
5	.00	1.8	1.7	1.5	1.85	[a] .00	1.8	1.8	2.0	.00	.00	.00
6	.00	1.9	1.7	1.5	1.9	.00	1.8	1.8	2.1	.00	.00	.00
7	.00	1.9	1.7	1.5	1.9	.00	1.8	1.8	2.1	.00	.00	.00
8	.00	1.9	1.7	1.5	1.9	2.0	1.8	1.8	2.1	.00	.00	.00
9	.00	1.9	1.7	1.8	1.9	1.9	1.8	1.75	2.0	.00	.00	.00
10	.00	1.9	1.67	1.8	1.85	1.9	1.8	1.75	2.0	.00	.00	.00
11	.00	2.0	1.75	1.9	1.9	1.9	1.75	1.75	2.0	.00	.00	.00
12	.00	2.0	1.75	2.0	1.9	2.0	1.7	1.7	2.0	.00	.00	.00
13	.00	2.1	1.7	2.0	1.9	2.0	1.7	1.7	2.1	.00	.00	.00
14	.00	2.4	1.73	1.9	1.9	2.0	1.65	1.7	2.2	.00	.00	.00
15	.00	2.4	1.7	1.9	2.0	2.0	1.65	1.7	2.1	.00	.00	.00
16	.00	1.85	1.7	1.9	2.0	2.0	1.8	1.75	2.1	.00	.00	.00
17	.00	1.8	1.7	1.65	2.0	2.0	1.8	1.7	2.1	.00	.00	.00
18	.00	1.75	1.7	1.65	2.0	2.0	1.9	1.65	2.2	.00	.00	.00
19	.00	1.75	1.7	1.65	2.0	2.0	1.9	1.9	2.2	.00	.00	.00
20	.00	1.7	1.75	1.85	1.95	2.0	1.9	1.9	2.3	.00	.00	.00
21	.00	1.7	1.7	1.9	2.0	2.0	1.95	2.2	2.3	.00	.00	.00
22	.00	1.8	1.65	1.9	1.9	2.0	1.95	2.2	2.3	.00	.00	.00

[a] Dry, January 1 to February 2; June 5, 6, 7; July 26, 27; September 28 to December 31.

Mean daily gage height, in feet, of Rawson canal near Bishop, Cal., etc.—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1904.												
23	0.00	1.75	1.65	1.9	1.9	2.0	2.2	2.25	2.3	.00	0.00	0.00
24	.00	1.75	1.7	1.9	1.9	1.9	1.4	2.25	2.3	.00	.00	.00
25	.00	1.7	1.7	1.9	1.9	1.9	1.4	2.3	2.3	.00	.00	.00
26	.00	1.75	1.55	1.85	1.9	1.9	a.0	2.3	2.3	.00	.00	.00
27	.00	1.7	1.5	1.9	1.9	1.9	.00	2.3	2.4	.00	.00	.00
28	.00	1.7	1.5	1.9	1.9	1.9	1.95	2.3	a.00	.00	.00	.00
29	.00	1.7	1.55	1.9	1.9	1.9	1.95	2.3	.00	.00	.00	.00
30	.00	.....	1.55	1.9	1.9	1.9	1.85	2.25	.00	.00	.00	.00
31	.00	.....	1.5	.....	2.0	.....	1.8	2.3	.....	.00	.....	.00

Rating table for Rawson canal near Bishop, Cal., from January 1 to May 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.30	1	1.60	14	1.90	29	2.20	48
1.40	5	1.70	18	2.00	35	2.30	55
1.50	9	1.80	23	2.10	41		

Rating table for Rawson canal near Bishop, Cal., from June 1 to September 30, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.40	5	1.70	16	2.00	26	2.30	37
1.50	9	1.80	19	2.10	30	2.40	40
1.60	12	1.90	23	2.20	33		

Estimated monthly discharge of Rawson canal near Bishop, Cal., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
February	59	0	26.2	1,403
March	20	9	16.6	1,018
April	35	9	22.1	1,319
May	35	26	30	1,845
June	27	0	23.1	1,374
July	25	0	20	1,230
August	37	16	26	1,599
September	40	0	29	1,726
The period	.....	.....	.....	11,514

A. O. COLLINS'S CANAL NEAR BISHOP, CAL.

This station was established August 7, 1903, by R. S. Hawley. It is located at the county bridge; 3 miles east of Bishop, Cal. The gage is a vertical rod fastened to the right bank, just above the bridge from which discharge measurements are made. It is read once each day by Paul McDonald. The initial point for soundings is marked on the foot log near the right bank of the canal. The channel is straight for 100 feet above and for 50 feet below the station. The current is sluggish. Both banks are high and are not liable to overflow. The bed of the stream is sandy and shifting.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of A. O. Collins's canal near Bishop, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
July 31	R. S. Hawley	.....	12.1
August 7	do	2.2	8.3
August 11	do	2.0	3.9
August 17	do	1.82	2.6
August 27	do	2.1	8.8
September 7	do	2.1	7.9
September 14	do	2.1	7.6
October 23	do	1.65	1.2
1904.			
February 4	R. S. Hawley	1.80	5.2
April 14	do	1.95	7.8
June 8	do	3.67	40
June 12	J. C. Clausen and L. M. Barnes	3.80	28
August 6	L. M. Barnes	3.45	19.8
August 20	do	3.35	14.3
September 6	R. S. Hawley	3.29	17.1
October 10	R. S. Hawley and R. J. Taylor	2.73	4.4
October 14	W. B. Clapp, R. S. Hawley, and R. J. Taylor	2.58	2.8
November 1	R. J. Taylor	2.50	2.1
December 1	do	2.48	1.8

Mean daily gage height, in feet, of A. O. Collins's canal near Bishop, Cal., for 1903 and 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
1	.....	.....	.....	.....	.....	.....	.....	.....	2.06	2.40	1.99	1.60
2	.....	.....	.....	.....	.....	.....	.....	.....	2.10	2.00	1.99	1.52
3	.....	.....	.....	.....	.....	.....	.....	.....	2.10	1.65	2.00	1.60
4	.....	.....	.....	.....	.....	.....	.....	.....	2.10	1.65	2.00	1.65
5	.....	.....	.....	.....	.....	.....	.....	.....	2.01	2.10	2.00	1.60
6	.....	.....	.....	.....	.....	.....	.....	.....	2.01	2.30	2.40	1.90
7	.....	.....	.....	.....	.....	.....	.....	.....	2.01	2.40	2.00	1.85
8	.....	.....	.....	.....	.....	.....	.....	.....	2.01	2.40	2.10	1.90
9	.....	.....	.....	.....	.....	.....	.....	.....	2.01	2.00	2.00	1.90
10	.....	.....	.....	.....	.....	.....	.....	.....	2.02	1.65	2.20	1.82
11	.....	.....	.....	.....	.....	.....	.....	2.00	2.02	1.65	2.10	1.80
12	.....	.....	.....	.....	.....	.....	.....	1.80	2.03	1.65	2.40	1.80
13	.....	.....	.....	.....	.....	.....	.....	1.80	2.07	1.65	2.30	1.60
14	.....	.....	.....	.....	.....	.....	.....	1.80	2.02	1.65	1.50	1.72
15	.....	.....	.....	.....	.....	.....	.....	1.80	2.03	1.65	1.50	1.72
16	.....	.....	.....	.....	.....	.....	.....	1.70	2.04	1.65	1.66	1.90
17	.....	.....	.....	.....	.....	.....	.....	1.82	2.14	1.65	1.80	1.70
18	.....	.....	.....	.....	.....	.....	.....	1.74	2.10	1.65	1.81	2.10
19	.....	.....	.....	.....	.....	.....	.....	2.20	2.07	1.65	1.82	1.70
20	.....	.....	.....	.....	.....	.....	.....	2.12	2.09	1.65	1.80	1.72
21	.....	.....	.....	.....	.....	.....	.....	2.10	2.07	1.65	1.80	1.70
22	.....	.....	.....	.....	.....	.....	.....	2.04	2.20	1.65	1.83	1.73
23	.....	.....	.....	.....	.....	.....	.....	2.10	2.30	1.65	1.60	1.70
24	.....	.....	.....	.....	.....	.....	.....	2.10	2.40	1.65	1.62	1.72
25	.....	.....	.....	.....	.....	.....	.....	2.03	2.50	2.40	1.53	1.70
26	.....	.....	.....	.....	.....	.....	.....	2.03	2.40	2.50	1.51	1.70
27	.....	.....	.....	.....	.....	.....	.....	2.10	2.70	2.40	1.50	1.70
28	.....	.....	.....	.....	.....	.....	.....	2.01	2.40	2.40	1.65	1.70
29	.....	.....	.....	.....	.....	.....	.....	2.10	2.04	2.40	1.51	1.70
30	.....	.....	.....	.....	.....	.....	.....	2.00	2.40	2.06	1.65	1.70
31	.....	.....	.....	.....	.....	.....	.....	2.04	.....	2.09	.....	1.70
1904.												
1	[a] 0.00	0.00	1.80	1.70	1.90	2.20	3.90	3.50	3.25	2.90	2.50	2.50
2	.00	.00	1.80	1.65	1.90	3.00	4.00	3.55	3.20	2.90	2.50	.....
3	.00	.00	1.80	1.65	1.85	3.20	4.00	3.55	3.10	2.90	.....	.....
4	.00	.00	1.80	2.00	1.80	3.40	4.00	3.50	3.10	3.00	.....	.....
5	.00	.00	1.85	2.00	1.80	3.50	4.00	3.50	3.30	3.00	.....	.....
6	.00	.00	1.80	2.00	1.80	3.50	4.00	3.45	3.30	3.10	2.50	.....
7	.00	.00	1.78	2.00	1.80	3.50	3.90	3.45	3.30	3.20	2.50	.....
8	.00	.00	2.00	2.00	1.80	3.60	3.90	3.50	3.30	3.00	.....	.....
9	.00	.00	2.00	2.00	1.80	3.60	3.90	3.50	3.30	2.80	.....	.....
10	.00	.00	2.10	2.00	1.75	3.70	3.90	3.45	3.25	2.80	2.50	.....
11	.00	2.00	2.00	1.80	1.75	3.70	3.90	3.40	3.20	.....	2.50	.....
12	.00	2.60	2.10	2.00	1.80	3.80	3.85	3.40	3.20	2.80	2.50	.....
13	.00	2.60	2.00	1.90	1.95	3.80	3.80	3.35	3.30	2.90	.....	.....
14	.00	2.50	2.00	1.90	1.95	3.90	3.80	3.45	3.30	2.90	2.50	.....
15	.00	2.50	2.00	1.90	3.10	4.00	3.75	3.50	3.20	2.90	2.50	.....
16	.00	2.60	2.00	1.90	3.10	4.00	3.70	3.45	3.20	.....	2.50	.....
17	.00	2.60	2.10	2.10	3.10	4.00	3.70	3.40	3.20	2.80	2.50	.....
18	.00	2.70	2.00	2.00	3.10	4.00	3.60	3.40	3.30	2.80	2.50	.....
19	.00	2.50	1.70	2.00	3.20	4.00	3.60	3.35	3.30	[a] .00	2.50	.....
20	.00	2.60	1.70	2.20	3.20	4.00	3.60	3.30	3.30	.00	.....	.....

[a] Dry: January 1 to February 10; October 19–25.

Mean daily gage height, in feet, of A. O. Collins's canal near Bishop, Cal., etc.—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1904.												
21	0.00	2.25	1.70	2.40	3.20	4.00	3.60	3.30	3.30	0.00	.....	.....
22	.00	2.20	1.70	2.40	3.10	4.00	3.60	3.35	3.30	.00	.....	.....
23	.00	2.10	1.70	2.40	3.20	4.10	3.70	3.30	3.30	.00	.....	.....
24	.00	1.90	1.70	2.40	3.20	4.10	3.65	3.30	3.30	.00	.....	.....
25	.00	1.80	1.70	2.40	1.80	4.10	3.70	3.30	4.00	.00	.....	2.40
26	.00	1.85	1.70	2.10	1.80	4.00	3.70	3.30	3.90	2.50	.....	.....
27	.00	1.80	1.90	2.40	1.80	4.00	3.70	3.30	3.90	2.50	2.50	.....
28	.00	1.80	1.90	2.00	1.80	.....	3.65	3.30	3.00	.....	.....	2.30
29	.00	1.80	1.90	2.10	1.70	4.00	3.50	3.30	3.10	2.50	2.50	.....
30	.00	.....	1.90	2.00	1.70	4.00	3.50	3.30	.....	2.50	2.50	.....
31	.00	.....	1.70	.....	1.60	.....	3.50	3.30	.....	2.50	.....	2.20

Rating table for A. O. Collins's canal near Bishop, Cal., from January 1 to June 30, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.50	1	2.20	12	2.90	26	3.50	38
1.60	2	2.30	14	3.00	28	3.60	40
1.70	3	2.40	16	3.10	30	3.70	42
1.80	4	2.50	18	3.20	32	3.80	44
1.90	6	2.60	20	3.30	34	3.90	46
2.00	8	2.70	22	3.40	36	4.00	48
2.10	10	2.80	24				

Rating table for A. O. Collins's canal near Bishop, Cal., from July 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.40	1	2.90	8	3.30	16	3.70	24
2.50	2	3.00	10	3.40	18	3.80	27
2.60	3	3.10	12	3.50	20	3.90	30
2.70	4	3.20	14	3.60	22	4.00	33
2.80	6						

Estimated monthly discharge of A. O. Collins's canal near Bishop, Cal., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
February	22	0	12.9	486
March	10	3	5.6	344
April	16	2	9	536
May	32	2	12.8	787
June	50	12	43.1	2,565
July	33	20	26	1,599
August	21	16	18	1,107
September	33	10	16	952
October	14	0	5	307
November	2	2	2	119
December	2	0	[a] 2	123
The period				8,925

[a] Assumed 2 as mean for December.

DELL CANAL NEAR BISHOP, CAL.

This station was established August 24, 1903, by R. S. Hawley. It is located at a flume 3 miles from the head-gate at a point where the canal crosses a slough in Sanders's field. The gage is a vertical rod fastened to the flume. Discharge measurements are made from a bridge across the flume. The observer is F. Sanders. The initial points for soundings is the edge of the flume at the right side. The channel is straight for 150 feet above and for 200 feet below the station. The current is sluggish at all times.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Dell canal near Bishop, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
August 11	R. S. Hawley		24.2
August 20	do		11.0
August 24	do		10.0
August 24	do	0.85	8.0
September 4	do	.78	7.0
September 22	do	1.47	19.6
October 7	do	1.52	19.0

Discharge measurements of Dell canal near Bishop, Cal., in 1903 and 1904—Continued.

Date.	Hyrographer.	Gage height.	Discharge
1904.		*Feet.*	*Second-feet.*
March 16	R. S. Hawley	1.40	22.0
April 15	do	1.31	17.9
May 28	do	1.60	19.0
June 20	do	1.80	23.0
July 14	J. C. Clausen and L. M. Barnes	1.80	16.9
August 11	L. M. Barnes	1.90	22.0
September 8	R. S. Hawley	1.39	14.5
November 17	R. J. Taylor	1.05	12.0
December 12	do	1.10	11.0

Mean daily gage height, in feet, of Dell canal near Bishop, Cal., for 1903 and 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1903.											
1									0.79	0.80	0.90
2									.80	.80	.90
3									.80	.81	.90
4									.79		.91
5									.79	.80	.91
6										.80	.92
7									.78	.81	.92
8									.78	.81	
9									.79	.80	.95
10									.80	.80	.94
11									.80		.95
12									.80	.82	.95
13									.80	.82	1.01
14									.79	.83	1.02
15									.79	.83	
16									.80	.83	1.06
17									.80	.84	1.08
18									.78		1.11
19									.78	.84	1.12
20										.85	1.14
21									.79	.86	1.13
22									.80	.86	1.12
23								0.85	.81	.86	1.11
24								.85	.81	.87	1.12
25								.86	.80	.88	1.15
26								.86	.81	.88	1.16
27										.89	1.12
28								.85	.78	.81	(a)
29								.85	.78	.89	
30									.79	.89	
31										.89	

a No record obtained from November 27, to December 31, 1903, when the water was turned out.

Mean daily gage height, in feet, of Dell canal near Bishop, Cal., etc.—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1904.											
1	[a]0.00	0.00	1.40	0.00	1.30	1.60	1.80	1.80	1.90	([b])	.....
2	.00	.00	.....	.00	.....	.....	.....	1.80	.....	.....	.....
3	.00	.00	.....	.00	1.30	1.60	1.80	.....	1.90	.....	.....
4	.00	.00	.....	.00	.....	1.60	.....	1.80	.....	.....	.....
5	.00	.00	.....	.....	1.40	.....	1.80	.....	1.90	.....	.....
6	.00	.00	.....	1.30	.....	1.60	.....	1.80	.....	.....	.....
7	.00	.00	.....	.....	1.30	.....	1.80	.....	1.90	.....	.....
8	.00	.00	.....	1.30	.....	1.60	.....	1.80	.....	.....	.....
9	.00	.00	.....	.....	1.40	.....	1.70	.....	1.90	.....	.....
10	.00	.00	.....	1.40	.....	1.60	.....	1.90	.....	.....	.....
11	.00	.00	.....	1.40	1.50	.....	1.70	.....	.....	.....	.....
12	.00	.00	.....	.....	.....	1.60	.....	1.90	1.90	.....	.....
13	.00	.00	.....	1.30	1.60	.....	1.80	.....	.....	.....	.....
14	.00	.00	.....	.....	.....	1.70	.....	1.90	1.90	.....	.....
15	.00	.00	.....	1.30	1.60	.....	.....	.....	.....	.....	.....
16	.00	.00	1.40	.....	.....	1.80	1.70	1.90	1.90	.....	.....
17	.00	.00	.....	1.30	1.60	.....	.....	.....	.....	.....	.....
18	.00	.00	.....	.....	.....	1.80	1.70	1.90	1.90	.....	.....
19	.00	.00	.....	1.40	1.60	.....	.....	.....	.....	.....	.....
20	.00	.00	.....	.....	.....	1.80	.....	1.90	1.90	.....	.....
21	.00	.00	.....	.....	1.60	.....	1.80	1.90	.....	.....	.....
22	.00	.00	1.40	1.40	.....	1.80	.....	.....	1.90	.....	.....
23	.00	.00	[a].00	.....	1.70	.....	1.80	1.90	.....	.....	.....
24	.00	.00	.00	1.40	.....	1.80	.....	.....	1.90	.....	.....
25	.00	.00	.00	.....	1.70	.....	1.80	1.90	.....	.....	.....
26	.00	.00	.00	1.30	.....	1.80	.....	.....	1.90	.....	.....
27	.00	.00	.00	.....	1.70	.....	1.80	1.90	.....	.....	.....
28	.00	.00	.00	1.30	1.60	1.80	.....	1.90	1.90	.....	.....
29	.00	.00	.00	.....	.....	.....	.....	.....	.....	.....	.....
30	.00	.....	.00	1.30	1.60	1.80	1.80	1.90	1.90	.....	.....
31	.00	.....	.00	.....	.....	.....	.....	.....	.....	.....	.....

[a] Dry: January 1 to February 29; March 23 to April 5.
[b] No record; October 1 to December 31.

Estimated monthly discharge of Dell canal near Bishop, Cal., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
March	21	0	15	922
April	21	0	16	952
May	21	9	15.7	970
June	24	18	21.2	1,304
July	18	15	16.1	984
August	22	18	21	1,291
September	22	22	22	1,309
The period				7,732

NOTE.—Discharge interpolated for missing days. The discharge has been obtained indirectly from measurements.

BIG PINE AND OWENS RIVER CANAL NEAR BISHOP, CAL.

This station was established by J. C. Clausen and R. S. Hawley August 4, 1903. It is located at a footbridge near the house of William Oliver, the observer. It is 7½ miles south and 3 miles east of Bishop, Cal. The gage is a vertical rod securely nailed to the footbridge. Discharge measurements are made from the footbridge. The initial point for soundings is marked on the footbridge near the right bank of the canal. The channel is straight for 600 feet above and for 300 feet below the station. The current is sluggish. Both banks are high and are not liable to overflow. The bed of the stream is sandy and somewhat shifting.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Big Pine and Owens River canal near Bishop, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
August 4	R. S. Hawley	1.60	19.0
August 11	do	1.55	16.3
August 20	do	1.50	17.3
September 14	do	.90	1.3
September 22	do	1.15	4.3
October 27	do	2.29	46.4
1904.			
March 16	R. S. Hawley	2.42	59
May 28	do	2.90	58
June 20	do	3.31	91
July 14	J. C. Clausen and L. M. Barnes	2.40	32
August 11	L. M. Barnes	2.60	29
September 8	R. S. Hawley	1.51	10.6

Mean daily gage height, in feet, of Big Pine and Owens River canal near Bishop, Cal., for 1903 and 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
1									0.90	1.20	2.53	2.35
2									.90	1.25	2.58	2.40
3									.90	1.35	2.53	2.40
4									.90	1.35	2.53	2.40
5								1.55	.90	1.50	2.53	2.30
6								1.50	.90	1.80	2.53	2.30
7								1.63	.90	1.90	2.53	2.30
8								1.62	.90	1.95	2.57	2.30
9								1.80	.90	1.95	2.57	2.35

Mean daily gage height, in feet, of Big Pine and Owens River canal, etc.—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec
1903.												
10	.....	.....	.....	.....	.....	.....	.....	1.70	0.97	2.03	2.57	2.35
11	.....	.....	.....	.....	.....	.....	.....	1.53	.98	2.22	2.62	2.35
12	.....	.....	.....	.....	.....	.....	.....	1.55	1.00	2.25	2.57	2.35
13	.....	.....	.....	.....	.....	.....	.....	1.40	1.00	2.25	2.57	1.50
14	.....	.....	.....	.....	.....	.....	.....	1.40	1.05	2.27	2.60	1.50
15	.....	.....	.....	.....	.....	.....	.....	1.40	1.05	2.40	2.60	1.50
16	.....	.....	.....	.....	.....	.....	.....	1.60	1.05	2.42	2.55	1.50
17	.....	.....	.....	.....	.....	.....	.....	1.60	1.05	2.45	2.55	1.50
18	.....	.....	.....	.....	.....	.....	.....	1.60	1.10	2.42	2.50	1.52
19	.....	.....	.....	.....	.....	.....	.....	1.60	1.15	2.43	2.50	1.58
20	.....	.....	.....	.....	.....	.....	.....	1.60	1.15	2.45	2.50	1.47
21	.....	.....	.....	.....	.....	.....	.....	1.40	1.12	2.47	2.53	1.48
22	.....	.....	.....	.....	.....	.....	.....	1.40	1.10	2.46	2.53	1.53
23	.....	.....	.....	.....	.....	.....	.....	1.40	1.10	2.30	2.53	1.53
24	.....	.....	.....	.....	.....	.....	.....	1.40	1.10	2.30	2.43	1.47
25	.....	.....	.....	.....	.....	.....	.....	1.35	1.10	2.33	2.41	1.47
26	.....	.....	.....	.....	.....	.....	.....	1.35	1.10	2.32	2.35	1.50
27	.....	.....	.....	.....	.....	.....	.....	1.75	1.12	2.28	2.35	1.50
28	.....	.....	.....	.....	.....	.....	.....	1.75	1.15	2.27	2.35	1.50
29	.....	.....	.....	.....	.....	.....	.....	1.75	1.18	2.25	2.38	1.50
30	.....	.....	.....	.....	.....	.....	.....	1.30	1.22	2.45	[illegible]	1.50
31	.....	.....	.....	.....	.....	.....	.....	.90	.....	2.45	.....	[illegible]
1904.												
1	[a]0.00	1.95	2.5	1.6	1.7	2.6	2.7	2.6	2.12	2.7	1.45	1.4
2	.00	1.95	2.5	1.45	1.6	2.6	2.7	2.6	2.12	2.65	1.4	1.4
3	1.45	1.96	2.55	1.4	1.6	2.6	2.7	2.6	2.06	2.6	1.4	1.3
4	1.45	1.87	2.55	1.45	1.6	2.9	2.6	2.65	1.8	2.65	1.4	1.4
5	1.45	2.1	2.45	1.0	1.55	3.1	2.6	2.63	1.8	2.65	1.4	1.4
6	1.43	2.0	2.35	1.0	1.5	3.1	2.6	2.55	1.6	1.65	1.4	1.4
7	1.43	2.05	2.35	1.0	1.4	3.1	2.6	2.55	1.55	1.7	1.35	1.3
8	1.43	1.92	2.35	[a].00	1.4	3.2	2.6	2.55	1.5	1.6	1.35	1.25
9	1.45	1.83	2.4	.00	1.4	3.1	2.6	2.6	1.5	1.6	1.35	1.2
10	1.45	1.72	2.4	.00	1.4	3.0	2.6	2.65	1.5	1.55	1.35	1.2
11	1.43	1.73	2.75	.00	1.4	3.0	2.5	2.6	1.5	1.55	1.35	1.25
12	1.43	1.86	2.7	.00	1.4	3.0	2.5	2.42	1.45	2.0	1.35	1.2
13	2.0	1.95	2.3	.00	1.45	3.1	2.4	2.42	1.45	1.65	1.35	1.2
14	1.82	2.03	2.3	.00	1.45	3.3	2.4	2.33	1.5	1.55	1.35	1.2
15	1.83	2.03	2.35	1.65	1.55	3.3	2.3	2.3	1.4	1.55	1.35	1.2
16	1.86	2.5	2.5	1.65	1.95	3.4	2.2	2.3	1.45	1.5	1.35	1.2
17	1.87	2.6	2.4	1.6	2.25	3.5	1.6	2.3	1.45	1.5	1.35	1.2
18	1.86	2.03	2.4	1.6	1.7	3.5	1.4	2.3	1.55	1.5	1.35	1.2
19	1.87	1.8	2.4	1.8	2.2	3.4	2.2	2.2	1.6	1.45	1.35	1.2
20	1.8	1.72	2.4	1.8	2.35	3.4	2.2	2.2	1.6	1.45	1.35	1.2
21	1.95	2.33	2.5	1.9	2.2	3.3	2.1	2.2	1.7	1.45	1.4	1.2
22	2.0	2.3	2.3	1.85	2.2	3.3	2.2	2.1	1.7	1.45	1.4	1.2
23	2.0	2.5	2.2	2.05	2.23	3.2	2.3	2.16	1.75	1.45	1.35	1.25
24	2.0	2.7	2.2	1.95	2.5	3.2	2.4	2.16	1.85	1.5	1.35	1.25
25	2.0	2.65	1.8	1.9	2.85	3.1	2.5	2.16	2.75	1.5	1.35	1.25
26	1.9	2.6	1.6	1.9	3.0	3.1	2.5	2.1	3.25	1.5	1.35	1.25
27	1.9	2.66	1.7	1.8	3.0	3.0	2.5	2.16	2.8	1.5	1.35	1.2
28	1.9	2.67	2.0	1.8	2.9	2.9	2.5	2.15	2.7	1.5	1.4	1.2
29	1.9	2.5	2.1	1.8	2.8	2.8	2.5	2.06	2.55	1.5	1.4	1.2
30	1.9	.....	1.9	1.7	2.75	2.8	2.4	2.0	2.75	1.5	1.4	1.2
31	1.9	.....	1.6	.....	2.75	.....	2.4	2.0	.....	1.45	.....	1.3

[a] Dry: January 1, 2; April 8-14.

Rating table for Big Pine and Owens River canal near Bishop, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.20	5	1.80	16	2.40	30	3.00	68
1.30	6	1.90	18	2.50	33	3.10	76
1.40	8	2.00	20	2.60	38	3.20	85
1.50	10	2.10	22	2.70	43	3.30	94
1.60	12	2.20	24	2.80	50	3.40	103
1.70	14	2.30	27	2.90	59		

Estimated monthly discharge of Big Pine and Owens River canal near Bishop, Cal., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January	20	0	14	861
February	43	14	24.7	1,421
March	46	12	28	1,722
April	21	3	10	595
May	64	8	23.8	1,466
June	114	38	75.2	4,474
July	43	8	31.2	1,918
August	41	20	29	1,783
September	90	8	21	1,250
October[a]	43	9	16	984
November	9	7	7	416
December	8	5	5.8	357
The year	114	0	23.8	17,247

[a] Head gate shut down October 6. Water flowing after that date is leakage.

SANGER CANAL AT ALVORD, CAL.

This station was established August 4, 1903, by J. C. Clausen and R. S. Hawley. It is located at the county road bridge, one-fourth mile east of the Southern Pacific Railway station at Alvord, Cal. The gage is a vertical rod, fastened to the bridge from which discharge measurements are made. It is read once each day by John Hale. The initial point for soundings is marked on the bridge near the left bank of the canal. The channel is straight for 300 feet above and for 100 feet below the station. The current is sluggish. Both banks are low and liable to overflow. The bed of the stream is shifting.

The observations at this station dnring 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Sanger canal at Alvord, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
August 4	R. S. Hawley	2.00	3.1
August 13	do	2.60	10.0
September 8	do	2.45	11.3
September 22	do	2.26	10.1
October 27	do	2.70	14.5
December 4	do	2.30	13.4
1904.			
January 27	R. S. Hawley	1.90	6.6
April 6	do	2.00	9.7
July 14	J. C. Clausen and L. M. Barnes	3.05	10.3
August 11	L. M. Barnes	3.20	15.4
September 8	R. S. Hawley	2.80	7.3
October 9	R. S. Hawley and R. J. Taylor	2.75	14.4
November 17	R. J. Taylor	2.52	15.3
December 9	do	2.30	11.0

Mean daily gage height, in feet, of Sanger canal at Alvord, Cal., for 1903 and 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct	Nov.	Dec.
1903.												
1										2.50	2.60	2.40
2											2.60	
3										2.50	2.60	2.40
4										2.50	2.55	
5											2.50	2.40
6										2.50	2.50	2.40
7											2.50	
8										2.50	2.40	2.30
9											2.40	
10										2.50	4.40	2.30
11										2.20	2.40	
12											2.40	2.30
13										2.50	2.30	2.30
14											2.30	
15										2.50	2.30	2.30
16												
17										2.50	2.30	2.30
18										2.60		
19										2.60	2.40	2.30
20										2.60		2.30
21											2.50	
22										2.60	2.50	2.30

Mean daily gage height, in feet, of Sanger canal at Alvord, Cal., etc.—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
23	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
24	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.60	2.50	2.30
25	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.60	.....	.....
26	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.50	2.30
27	.....	.....	.....	.....	.....	.....	.....	.....	2.60	2.50	.....	2.30
28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.50	2.30
29	.....	.....	.....	.....	.....	.....	.....	.....	2.60	2.50	2.40	2.30
30	.....	.....	.....	.....	.....	.....	.....	.....	2.50	.....	2.40	2.30
31	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.40	.....	2.30
1904.												
1	2.3	1.9	1.9	1.9	2.7	3.0	3.2	3.4	3.1	2.5	2.6	2.5
2	2.3	.....	1.9	1.9	.....	3.0	3.2	3.4	3.0	2.5	2.6	2.5
3	2.3	2.5	1.9	1.9	2.7	3.0	3.2	3.4	2.9	2.5	2.6	2.5
4	.....	.....	1.9	1.9	.....	3.0	3.2	3.4	2.8	2.5	2.6	(a)
5	1.9	2.5	1.9	1.9	2.7	3.0	3.2	3.4	2.7	2.4	2.6	.....
6	.....	2.5	.....	2.3	.....	3.0	3.2	3.4	2.7	2.4	2.6	.....
7	1.9	2.5	1.9	.....	2.7	3.0	3.2	3.4	2.7	2.4	2.6	.....
8	.....	.....	.....	2.3	2.7	3.2	3.2	3.4	2.7	2.35	2.6	.....
9	1.9	1.9	1.9	2.3	2.7	3.2	3.2	3.4	2.7	2.35	2.6	.....
10	1.9	.....	.....	2.3	2.7	3.2	3.1	3.4	2.7	2.4	2.6	.....
11	.....	1.9	1.9	2.3	2.8	3.2	3.0	3.4	2.7	2.5	2.6	.....
12	1.9	.....	1.9	.....	2.8	3.2	3.0	3.4	2.7	2.6	2.6	.....
13	1.9	1.9	.....	2.5	2.8	3.2	2.9	3.4	2.7	2.6	2.6	.....
14	1.9	1.9	1.9	.....	2.9	3.2	2.9	3.4	2.7	2.6	2.6	.....
15	.....	.....	.....	2.5	2.9	3.2	2.9	3.4	2.7	2.7	2.6	.....
16	1.9	1.9	1.9	2.5	2.9	3.2	2.9	3.4	2.7	2.7	2.6	.....
17	1.9	1.9	2.1	2.5	2.9	3.2	2.9	3.4	2.7	2.7	2.6	.....
18	.....	.....	.....	.....	2.9	3.2	3.0	3.4	2.7	2.7	2.6	.....
19	1.9	1.9	2.1	2.5	2.9	3.2	3.0	3.4	2.7	2.7	2.6	.....
20	.....	1.9	2.1	.....	3.0	3.2	3.0	3.4	2.7	2.7	2.6	.....
21	1.9	1.9	.....	2.5	3.0	3.2	3.2	3.4	2.7	2.7	2.6	.....
22	.....	.....	2.1	.....	3.0	3.2	3.2	3.4	2.7	2.7	2.6	.....
23	1.9	1.9	.....	2.5	3.0	3.2	3.2	3.4	2.7	2.7	2.6	.....
24	1.9	.....	2.1	2.5	.....	3.2	3.3	3.4	2.7	2.7	2.6	.....
25	1.9	1.9	.....	.....	3.0	3.2	3.3	3.4	2.7	2.7	2.6	.....
26	.....	.....	2.1	2.7	3.0	3.2	3.3	3.4	2.7	2.7	2.6	.....
27	1.9	1.9	.....	.....	3.0	3.2	3.3	3.4	2.7	2.7	2.6	.....
28	.....	1.9	.....	2.7	3.0	3.2	3.3	3.4	2.6	2.7	2.6	.....
29	1.9	1.9	1.9	.....	3.0	3.2	3.4	3.4	2.6	2.7	2.6	.....
30	1.9	.....	1.9	2.7	3.0	3.2	3.4	3.4	2.6	2.6	2.6	.....
31	.....	.....	1.9	.....	3.0	.....	3.4	3.4	.....	2.6	.....	.....

a No record for remainder of year.

EAST SIDE CANAL NEAR CITRUS, CAL.

This station was established August 27, 1903, by R. S. Hawley. It is located at the head-gate of the canal. The gage is a vertical rod fastened to the head-gate at which discharge measurements are made. The gage is read once each day by J. Vaughn. At low stages the meter measurements are made by wading at a point below head-gate.

High-stage measurements are made from Southern Pacific Railroad bridge, one-half mile below head-gate.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of East Side canal near Citrus, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
August 13	R. S. Hawley	1.95	32
August 27	do	2.00	44
September 16	do	1.98	36
October 30	do	2.95	80
December 4	do	3.23	96
1904.			
February 24	R. S. Hawley	1.55	35
April 6	do	1.70	28
May 3	do	1.60	24
June 9	do	2.50	50
July 22	L. M. Barnes	2.50	40
September 12	R. S. Hawley	2.60	42
October 9	R. S. Hawley and R. J. Taylor	2.60	45
November 4	R. J. Taylor	2.30	30
December 2	do	2.25	27

Mean daily gage height, in feet, of East Side canal near Citrus, Cal., for 1903 and 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
1												
2									2.00	2.00	3.00	3.20
3												
4									2.00		3.00	3.20
5										2.20		
6											3.00	(a)
7									2.00	2.30		(a)
8												(a)
9									2.00	2.30	3.00	2.35
10												
11									2.00		3.00	2.40
12										2.40		
13											3.00	
14									1.90	2.50		2.40
15												
16									2.00	2.60	3.00	2.40
17												
18									2.00		3.00	2.00

a Head-gate shut down.

Mean daily gage height, in feet, of East Side canal near Citrus, Cal., etc.—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
19										2.70		
20											3.00	
21									2.00	2.70		2.00
22												
23									2.00	3.10		2.40
24												
25									2.00		3.05	2.40
26										3.10		
27								2.00			3.15	
28								2.00	2.10	3.00		1.80
29												
30									2.10	2.00	3.15	
31								2.00				
1904.												
1		1.7		1.9			2.6	2.6				
2					1.9				2.6			2.4
3			1.8		1.6	2.4				2.5		
4	1.4			1.8			2.5				2.6	
5								2.6	2.5			2.1
6	1.4					2.4						(a)
7			1.8							2.4	2.5	
8		1.6					2.8	2.6				
9					1.6			b.00	2.6			
10						2.5		.00		2.6		
11	1.1		1.7	1.85			2.8	.00			2.6	
12		1.5						.00	2.6			
13					1.8	2.6		.00				
14	1.4		1.7					.00		2.8	2.5	
15		1.5		1.8			2.6	.00				
16					1.9			.00	2.6			
17						2.6		.00		2.3		
18	1.4	1.8	1.8	1.9			2.8	.00			2.5	
19								.00	2.6			
20	1.4					2.6		.00				
21			1.8					.00		2.4	2.4	
22		1.6					2.5	.00				
23					2.0			.00	2.6			
24						2.5		.00		2.4		
25	1.5		2.1	1.9			2.9	.00			2.5	
26		1.6						.00	2.7			
27					2.4	2.6		.00				
28			1.8					2.0		2.4	2.4	
29	1.6	1.5					2.8	2.4				
30					2.2				2.6			
31										2.5		

a Water shut off for remainder of the year.
b Dry August 9-27.

Rating table for East Side canal near Citrus, Cal., from July 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.50	3	1.90	18	2.30	32	2.70	48
1.60	7	2.00	21	2.40	36	2.80	52
1.70	11	2.10	25	2.50	40	2.90	55
1.80	14	2.20	28	2.60	44	3.00	59

Estimated monthly discharge of East Side canal near Citrus, Cal., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January	24	10	18.7	1,150
February	30	21	24.4	1,406
March	39	27	30.3	1,863
April	33	30	31.8	1,892
May	48	24	34	2,091
June	54	48	51.8	3,082
July	55	28	47	2,890
August 1-8, 27-31	44	21	40	1,031
September	48	40	44	2,618
October	52	32	39	2,398
November	44	36	40	2,380
The period				20,909

NOTE.—Discharge interpolated for missing days. From January 1 to June 30 no rating table was made, but discharge was based on measurements indirectly.

STEVENS CANAL NEAR CITRUS, CAL.

This station was established August 27, 1903, by R. S. Hawley. It is located at the waste gate of the canal, 3½ miles north of Citrus, Cal. The gage is a vertical rod fastened to the waste gate. It is read once each day by J. Vaughn. Discharge measurements are made by wading. The initial point for soundings is on the right bank of the canal. The channel is straight for 300 feet above and for 200 feet below the station. The current is sluggish. Both banks are high and are not liable to overflow. The bed of the stream is composed of gravel and earth and is fairly permanent.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Stevens canal near Citrus, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
August 13	R. S. Hawley		17.7
August 27	do	2.30	23.0
September 16	do	2.40	21.3
1904.			
February 24	R. S. Hawley	2.40	24.0
April 6	do		10.7
May 3	do	2.20	32.0
June 9	do	3.30	38.0
June 24	do	3.87	54.0
July 22	L. M. Barnes	3.20	22.0
September 12	R. S. Hawley	1.70	3.5

Mean daily gage height, in feet, of Stevens canal near Citrus, Cal., for 1903 and 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.										
1										
2							2.30	2.50		
3										
4							2.30			
5								2.50		
6										
7							2.35	2.50		
8										
9							2.35			
10										
11							2.30			
12										
13										
14							2.60			
15										
16							2.40			
17										
18							2.00			
19										
20										
21							2.40			
22										
23							2.00			
24										
25							2.00			
26										
27						2.30				
28						2.30	2.30			
29										
30							2.35			
31						2.30				

On October 7 the water was turned out.

Mean daily gage height, in feet, of Stevens canal near Citrus, Cal., etc.—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	Aug.	Sept.	Oct.	Nov.	Dec.
1904.										
1	(a)	1.9								
2	(a)				2.2				1.6	
3	(a)							2.5		
4	(a)		2.4						1.5	
5	(a)							2.5		1.5
6	(a)				2.2					
7	(a)		2.2					2.6	1.6	1.5
8	(a)	1.8								
9	(a)				2.0				1.5	1.5
10	(a)							2.5		
11	(a)		2.0						1.5	
12	(a)	1.7						2.5		1.5
13	(a)				2.2					
14	(a)		2.1					2.7	1.6	1.5
15	(a)	1.7								
16	(a)								1.6	1.5
17	(a)			2.2				2.3		
18	(a)		2.6						1.6	
19	(a)							2.4		1.5
20	(a)									
21	(a)						2.6	2.3	1.6	1.5
22	(a)	2.6								
23	(a)				2.3		2.6		1.6	1.5
24	(a)							1.6		
25	(a)		2.9	2.2					1.6	
26	(a)	2.5					2.7	1.5		1.5
27	(a)									
28	(a)						2.5	1.5	1.6	1.5
29	(a)	2.4								
30	1.7						2.5		1.6	1.5
31								1.6		

[a] Dry; January 1–29.

Observer discontinued taking gage height in May on account of high water. Could not cross river.

Rating table for Stevens canal near Citrus, Cal., from January 1 to June 30, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.40	14	1.70	17	2.00	20	2.30	23
1.50	15	1.80	18	2.10	21	2.40	24
1.60	16	1.90	19	2.20	22		

Rating table for Stevens canal near Citrus, Cal., from July 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.50	3.0	1.80	4.0	2.10	6	2.40	9
1.60	3.2	1.90	4.5	2.20	7	2.50	10
1.70	3.5	2.00	5.0	2.30	8		

Estimated monthly discharge of Stevens canal near Citrus, Cal., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
February	26	17	20.1	1,156
March	24	20	21.3	1,310
April	22	22	22	1,309
May	23	22	22	1,353
September 21-30	12	10	11	218
October	12	3	8	492
November	3	2	3	178
December	3	3	3	184
The period				6,200

NOTE.—Discharge interpolated for missing days.

OWENS RIVER NEAR CITRUS, CAL.

This station was established October 30, 1903, by R. S. Hawley. It is located at the county bridge 4 miles east of Independence, Cal., and 1 mile from the Southern Pacific Railway station at Citrus, Cal. The station at this point shows the amount of waste water which is discharged into Owens Lake. The gage is a 1 by 4 inch vertical rod nailed to a pile on the upstream side of the middle pier of the bridge. It is read twice each day by Milton Levy. Discharge measurements are made from the county bridge at which the gage is located. The initial point for soundings is the end of the rail at the right end of the bridge. The channel is straight for 200 feet above and for 300 feet below the station. The current has a mean velocity of about 2 feet at ordinary stages. Both banks are high and are not liable to overflow. The bed of the stream is sandy and is liable to shift. The bench mark is a copper tack in the floor beam directly over the gage rod. Its elevation is 1.50 feet above the 12-foot mark of the gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Owens River near Citrus, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
June 27	J. C. Clausen		534
August 28	R. S. Hawley	[a] 2.7	8.6
October 30	do	4.4	[a] 105
December 4	do	5.0	215
1904.			
January 27	R. S. Hawley	5.45	303
April 6	do	5.30	298
May 3	do	3.65	25
June 9	do	6.65	569
June 24	do	7.20	733
July 22	L. M. Barnes	4.80	176
September 12	R. S. Hawley	4.10	59
October 9	R. S. Hawley and R. J. Taylor	6.30	456
November 4	R. J. Taylor	5.90	410
December 2	do	5.80	351

[a] Corrected gage height and discharge.

Mean daily gage height, in feet, of Owens River near Citrus, Cal., for 1903 and 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
1											4.48	4.95
2											4.45	5.0
3											4.65	4.95
4											4.7	5.0
5											4.75	5.0
6											4.7	5.0
7											4.6	5.0
8											4.65	5.03
9											4.7	5.03
10											4.77	5.01
11											4.8	5.0
12											4.83	5.01
13											4.85	5.01
14											4.85	5.2
15											4.87	5.2
16											4.85	5.0
17											4.85	5.2
18											4.85	5.2
19											4.85	5.2
20											4.88	5.2
21											4.95	5.25
22											4.97	5.3
23											4.9	5.3
24											4.95	5.2

Mean daily gage height, in feet, of Owens River near Citrus, Cal., etc.—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1903.												
25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.0	5.15
26	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.0	5.15
27	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.0	5.2
28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.0	5.2
29	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.0	5.35
30	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.4	5.0	5.35
31	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.47	.....	5.35
1904.												
1	5.35	5.35	5.45	6.15	3.55	5.25	6.6	5.1	4.6	5.75	5.8	5.8
2	5.4	5.3	5.35	5.7	3.6	5.2	6.5	5.4	4.6	5.8	5.7	5.85
3	.....	5.25	5.15	5.55	3.65	5.1	6.45	5.5	4.55	5.7	5.9	(5.85)
4	5.35	5.25	5.3	5.35	3.6	5.0	6.4	5.55	4.6	6.0	5.9	5.9
5	5.4	5.05	5.35	5.25	3.6	5.3	6.35	5.8	4.65	6.0	5.9	5.9
6	5.4	5.05	5.25	5.3	3.55	5.8	6.3	5.7	4.5	6.0	5.85	5.8
7	5.4	5.0	5.15	4.9	3.55	6.2	6.2	5.7	.....	6.0	5.85	5.85
8	5.4	5.0	5.05	4.8	3.5	6.4	6.15	5.6	4.3	6.5	5.9	5.8
9	5.4	5.0	5.05	4.75	3.5	6.5	6.2	5.85	4.25	6.4	5.9	5.85
10	5.45	5.0	4.9	5.5	3.45	6.6	6.2	6.0	4.15	.....	5.85	5.85
11	5.45	5.0	4.95	5.55	3.5	6.5	6.1	6.3	4.05	5.9	5.85	5.8
12	5.4	4.9	5.0	5.4	3.4	6.4	6.1	6.2	4.05	6.1	5.85	5.8
13	5.4	4.85	5.3	5.35	3.45	6.4	6.0	5.9	4.05	6.2	5.8	5.8
14	5.4	4.9	5.1	5.3	3.45	6.4	5.8	5.9	4.1	6.5	5.8	5.8
15	5.4	4.85	5.0	5.2	3.45	6.5	5.65	5.6	4.1	6.5	5.8	5.8
16	5.4	4.9	5.0	5.15	3.4	6.8	5.55	5.65	4.1	6.3	5.85	(5.8)
17	5.4	5.45	5.2	4.15	3.4	6.8	5.4	5.6	4.1	6.4	5.8	(5.8)
18	5.4	5.4	5.25	3.9	3.4	6.8	5.2	5.5	4.1	6.3	5.75	(5.8)
19	5.45	5.7	5.2	3.95	3.8	7.0	5.0	5.55	4.1	6.1	5.8	(5.8)
20	5.4	5.7	5.15	3.9	4.1	7.3	5.0	5.6	4.1	6.0	5.75	(5.8)
21	5.4	5.6	5.2	3.7	4.1	7.3	4.9	5.35	3.85	.....	5.8	(5.75)
22	5.35	5.45	5.2	3.75	4.1	7.3	4.8	5.2	3.75	6.0	5.8	(5.75)
23	5.4	5.5	5.15	3.6	4.5	7.3	4.8	5.15	3.75	6.0	5.8	(5.7)
24	5.4	5.55	5.4	3.55	4.05	7.3	4.7	.....	3.75	6.0	5.8	(5.7)
25	5.45	5.5	6.0	3.5	4.1	7.2	4.8	.....	3.8	6.1	5.85	5.7
26	5.4	5.75	5.95	3.45	4.8	7.2	5.0	.....	4.2	5.9	5.85	5.6
27	5.45	5.5	5.6	3.4	4.9	7.0	4.8	5.1	5.6	5.8	5.8	5.65
28	5.4	5.7	5.8	3.4	5.5	6.8	5.2	.....	5.7	5.9	5.85	(5.65)
29	5.4	5.5	5.95	3.45	5.8	6.8	5.2	.....	5.75	5.9	5.8	(5.65)
30	5.35	.....	6.4	3.4	5.45	6.7	5.3	.....	5.8	5.9	5.8	(5.65)
31	5.4	.....	6.6	.....	5.35	.....	5.1	.....	.....	.....	.....	(5.65)

NOTE.—Gage heights in parenthesis are estimated.

Rating table for Owens River near Citrus, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.60	20	4.60	150	5.60	335	6.60	585
3.70	30	4.70	165	5.70	360	6.70	610
3.80	40	4.80	180	5.80	385	6.80	640
3.90	50	4.90	195	5.90	410	6.90	670
4.00	60	5.00	210	6.00	435	7.00	700
4.10	75	5.10	230	6.10	460	7.10	730
4.20	90	5.20	250	6.20	485	7.20	760
4.30	105	5.30	270	6.30	510	7.30	790
4.40	120	5.40	290	6.40	535	7.40	820
4.50	135	5.50	310	6.50	560		

Estimated monthly discharge of Owens River near Citrus, Cal., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January	300	280	290.3	17,851
February	372	187	267.5	15,387
March	585	195	289.9	17,823
April	472	2	160.5	9,552
May	385	2	76.8	4,720
June	790	210	572.5	34,064
July	585	165	350	21,521
August	510	230	318	19,553
September	385	35	125	7,438
October	560	360	451	27,731
November	410	360	388	23,088
December	410	335	378	23,242
The year	790	2	306	221,970

POWERS CANAL NEAR BISHOP, CAL.

This station was established August 19, 1903, by R. S. Hawley. It is located one-half mile above mill, on Bishop Creek, and 4½ miles west of Bishop, Cal. The gage is a 1 by 3 inch rod on left bank of canal. Discharge measurements are made by wading. The canal is straight for 20 feet above and 50 feet below the station. The bed of the canal is composed of gravel and is not subject to change. The bench mark is on granite bowlder 60 feet north of penstock of mill pressure pipe. Its elevation is 3.50 feet above the zero of gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Powers canal near Bishop, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
August 10	R. S. Hawley		6.2
August 19	do	1.50	6.8
August 25	do	1.48	6.8
September 3	do	1.33	2.8
September 9	do	1.41	4.9
September 15	do	1.38	3.5
September 21	do	1.36	3.6
1904.			
April 16	R. S. Hawley	1.40	4.4
May 17	do	1.50	6.1
July 12	J. C. Clausen and L. M. Barnes	1.75	16.6
August 6	L. M. Barnes	1.75	15.8
October 24	R. J. Taylor	1.40	3.9

Mean daily gage height, in feet, of Powers canal near Bishop, Cal., for 1904.[a]

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Day.	Mar.	Apr.	May.	June.	July.	Aug.
1	1.3	1.4					17			1.5	1.8		
2				1.5			18		1.4			1.7	1.85
3			1.4				19	1.3		1.5	1.8		
4				1.5			20						
5			1.4			1.8	21				1.8		
6							22			1.5		1.7	
7			1.5				23				1.8		
8		1.4			1.8		24						
9			1.5				25		1.4	1.5	1.8		
10							26						1.85
11			1.5		1.8		27			1.5	1.75	1.7	
12				1.6			28						
13			1.5				29				1.8		
14	1.3			1.6			30						
15					1.8		31	1.3					
16		1.4		1.7									

[a] No record January, February, September, October, November, December.

Rating table for Powers canal near Bishop, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet*	*Feet.*	*Second-feet.*
1.20	0	1.50	7	1.70	14	1.90	23
1.30	2	1.60	10	1.80	18	2.00	29
1.40	4						

Estimated monthly discharge of Powers canal near Bishop, Cal., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
March	.....	.....	2	123
April	.....	.....	4	238
May	7	4	6.4	394
June	18	7	12.8	762
July	18	14	16	984
August	20	18	19	1,168
The period	.....	.....	.....	3,669

SOUTH HILLSIDE CANAL NEAR BISHOP, CAL.

This station was established August 26, 1903, by R. S. Hawley. It is located just below the waste gate at head of canal, 5 miles west of Bishop, Cal. The gage is a 1 by 3 inch rod on left bank of canal. The discharge measurements are made by wading. The bench mark is on granite bowlder marked by ring of white paint and located on left bank 2 feet from gage; it is 2.99 feet above zero of gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of South Hillside canal near Bishop, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
August 26	R. S. Hawley	1.8	3.9
September 3	do	1.8	4.2
September 9	do	1.8	4.2
1904.			
February 20	R. S. Hawley	1.60	1.0
April 25	do	2.00	7.0
June 8	do	2.20	10.0
August 27	L. M. Barnes	1.90	5.1
September 7	R. S. Hawley	2.15	10.5
October 15	R. S. Hawley, W. B. Clapp, and R. J. Taylor	1.65	1.0
November 9	R. J. Taylor	1.63	1.1
December 5	do	1.50	.4

Mean daily gage height, in feet, of South Hillside canal near Bishop, Cal., for 1904.[a]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.
1								
2						1.5		
3					2.0			
4						1.5		
5					2.0			2.1
6								
7					2.0			
8								
9					2.0			
10								
11					2.0		1.9	
12			(b)			1.6		
13					2.0			
14						1.6		
15							1.9	
16						1.7		
17					2.0	1.8		
18							1.9	2.0
19					2.0	1.8		
20		1.6					2.0	
21						1.8		
22					2.0			
23	1.65			(c)		1.8		
24								
25					2.0	1.8		
26								2.0
27					2.0	1.75	2.0	
28								
29						1.8		
30								
31								

[a] No record for September, October, November, and December.
[b] Water turned out March 12 to April 22, inclusive.
[c] Water turned in.

Rating table for South Hillside canal near Bishop, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.50	0	1.70	2.5	1.90	5.5	2.10	8.5
1.60	1	1.80	4	2.00	7	2.20	10

Estimated monthly discharge of South Hillside canal near Bishop, Cal., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April 24–30	7	7	7	97
May	7	7	7	430
June	4	0	2	119
July	7	4	5.7	350
August	9	7	8	492
The period				1,488

NOTE.—Discharge interpolated for missing days.

NORTH HILLSIDE CANAL NEAR BISHOP, CAL.

This station was established September 3, 1903, by R. S. Hawley. It is located at head gate of the canal, 5 miles west of Bishop, Cal. The gage is a 1 by 3 inch vertical rod fastened to the right side of flume or head gate. Discharge measurements are made from crosspiece of flume on which the distances across are marked at each foot. The initial point for soundings is the end of crosspiece of flume at right bank. The bench mark is on a granite bowlder marked with white paint, and located near gage. It is 2.96 feet above zero of gage.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of North Hillside canal near Bishop, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
August 19	R. S. Hawley		10.6
August 25	do		9.5
September 3	do	1.99	11.2
September 9	do	1.95	11.1
October 26	do	1.77	4.3
1904.			
April 16	R. S. Hawley	1.76	4.6
April 25	do	1.95	10.3
May 17	do	2.00	13.0
June 20	do		13.5
July 12	J. C. Clausen and L. M. Barnes	2.00	13.8
August 8	L. M. Barnes	2.00	15.6
September 7	R. S. Hawley	1.90	9.3
October 15	R. S. Hawley, W. B. Clapp, and R. J. Taylor	1.70	4.4
November 9	R. J. Taylor	1.70	3.8
December 5	do	1.55	1.7

Mean daily gage height, in feet, of North Hillside canal near Bishop, Cal., for 1904.[a]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.
1	[b] 0.00	0.00	0.00	0.00	.....	.....	.....	.....
2	.00	.00	.00	.00	.....	2.05	.....	.....
3	.00	.00	.00	.00	2.05	.....	.....	.....
4	.00	.00	.00	.00	.....	2.05	.....	.....
5	.00	.00	.00	.00	2.05	.....	.....	2.2
6	.00	.00	.00	.00	.....	.....	.....	.....
7	.00	.00	.00	.00	2.05	.....	.....	.....
8	.00	.00	.00	.00	.....	.....	1.9	2.0
9	.00	.00	.00	.00	2.05	.....	.....	.....
10	.00	.00	.00	.00	.....	.....	.....	.....
11	.00	.00	.00	.00	2.05	.....	1.9	.....
12	.00	.00	.00	.00	.....	2.02	.....	.....
13	.00	.00	.00	.00	2.05	.....	.....	.....
14	.00	.00	.00	.00	.....	.....	.....	.....
15	.00	.00	.00	.00	.....	.....	2.0	.....
16	.00	.00	.00	1.76	.....	2.02	.....	.....
17	.00	.00	.00	.....	2.05	.....	.....	.....
18	.00	.00	.00	.....	.....	.....	2.1	2.2
19	.00	.00	.00	.....	2.05	2.0	.....	.....
20	.00	.00	.00	.....	.....	.....	.....	.....
21	.00	.00	.00	.....	.....	1.95	.....	.....
22	.00	.00	.00	.....	2.04	.....	2.1	.....
23	.00	.00	.00	1.95	.....	1.9	.....	.....
24	.00	.00	.00	.....	2.05	.....	.....	.....
25	.00	.00	.00	1.95	.....	1.9	.....	.....
26	.00	.00	.00	.....	.....	.....	.....	2.2
27	.00	.00	.00	.....	2.05	1.9	2.1	.....
28	.00	.00	.00	.....	.....	.....	.....	.....
29	.00	.00	.00	.....	.....	1.9	.....	.....
30	.00	.....	.00	.....	2.03	.....	.....	.....
31	.00	.....	.00	.....	.....	.....	.....	.....

[a] No record for September, October, November, and December. [b] Dry: January 1 to April 15.

Rating table for North Hillside canal near Bishop, Cal., from April 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.60	3	1.80	6	2.00	11	2.20	21
1.70	4	1.90	8	2.10	15		

Estimated monthly discharge of North Hillside canal near Bishop, Cal., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April	10	0	3.8	226
May	13	13	13	799
June	13	9	11.2	666
July	15	9	12.1	744
August	21	11	19	1,168
The period	.....	.....	.....	3,603

NOTE.—Discharge interpolated for missing days.

BIG PINE CREEK NEAR BIG PINE, CAL.

This station was established December 5, 1903, by R. S. Hawley. It is located 3 miles southwest of Big Pine, Cal., at a point where the creek leaves the foothills. The gage is a 1 by 3 inch vertical rod fastened to a tree on the left bank of the creek, 3 feet above the footbridge, from which discharge measurements are made. The initial point for soundings is on the footbridge near the right bank, and distances across the stream are marked at intervals of 1 foot. The channel is straight for 30 feet above and 50 feet below the station. The current is swift at all stages. Both banks are high and rocky. The bed of the stream is rough and rocky, and is not subject to much change. Bench mark No. 1 is on a granite bowlder marked by a ring of white paint, 40 feet southeast of the south end of the footbridge. It is 8.54 feet above the zero of the gage. Bench mark No. 2, which is 10.44 feet above the zero of the gage, is marked with a ring of white paint and is located 45 feet southwest of the south end of the footbridge. The gage is read once each day by Mrs. J. M. Randle.

The observations at this station during 1904 have been made under the direction of S. G. Bennett and W. B. Clapp, district hydrographers.

Discharge measurements of Big Pine Creek near Big Pine, Cal., in 1903 and 1904.

Date.	Hydrographer.	Gage height.	Discharge.
1903.		*Feet.*	*Second-feet.*
October 12	R. S. Hawley		16.4
August 14	do		112.4
December 5	do	1.8	8.5
1904.			
January 28	R. S. Hawley	1.80	11.1
February 10	do	1.82	16.5
April 22	do	2.00	22.0
June 4	R. S. Hawley and J. C. Clausen	2.95	105
September 10	R. S. Hawley	2.45	58
October 10	R. S. Hawley and R. J. Taylor	2.00	31
November 18	R. J. Taylor	1.90	21
December 9	do	1.90	20

Mean daily gage height, in feet, of Big Pine Creek near Big Pine, Cal., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.8	1.8	1.9	1.9	1.9	2.9	3.1	3.0	2.5	2.0	2.0	2.0
2	1.8	1.8	1.9	1.9	1.9	3.0	3.1	2.8	2.6	2.0	2.0	1.9
3	1.8	1.8	1.9	1.9	1.9	3.1	3.0	2.8	2.6	2.1	2.0	1.9
4	1.8	1.8	1.9	1.9	2.0	3.0	3.0	2.8	2.5	2.0	2.0	1.9
5	1.8	1.8	1.9	1.9	2.0	3.0	3.0	2.8	2.4	2.1	2.0	1.9
6	1.8	1.8	1.9	1.9	2.1	3.2	3.0	3.0	2.4	2.2	2.0	2.0
7	1.8	1.85	1.9	1.9	2.45	3.1	3.2	3.0	2.5	2.1	2.0	1.95
8	1.8	1.8	1.9	1.95	2.7	3.0	3.2	3.1	2.6	2.1	2.0	1.95
9	1.8	1.8	1.9	1.95	2.7	3.0	3.0	3.5	2.5	2.1	2.0	1.9
10	1.8	1.8	1.8	1.95	2.7	3.1	2.9	3.2	2.5	2.0	2.0	1.9
11	1.8	1.8	1.9	2.0	2.7	3.2	2.9	3.0	2.5	2.0	1.9	1.9
12	1.8	1.8	1.95	2.0	2.8	3.5	2.9	2.9	2.5	2.0	2.0	1.9
13	1.8	1.8	1.9	2.05	2.8	3.5	2.9	2.9	2.5	2.0	2.0	1.85
14	1.8	1.8	1.9	2.1	2.8	3.5	2.9	2.9	2.5	2.0	2.0	1.85
15	1.8	1.8	1.9	2.0	2.8	3.8	2.8	2.9	2.4	2.0	2.0	1.85
16	1.8	2.0	1.9	2.05	2.9	3.8	2.8	2.9	2.4	2.0	2.0	1.85
17	1.8	1.85	1.9	2.0	2.8	3.7	2.8	3.2	2.4	1.9	2.0	1.85
18	1.8	1.8	1.9	2.0	2.9	3.5	2.8	3.0	2.4	1.9	1.9	1.85
19	1.8	1.8	1.9	2.0	2.8	3.5	3.1	3.0	2.3	2.0	1.9	1.85
20	1.8	1.8	1.85	2.0	2.7	3.5	3.3	2.8	2.2	2.0	2.0	1.85
21	1.8	1.8	1.9	2.0	2.6	3.1	3.2	2.8	2.2	2.0	2.0	1.85
22	1.8	1.85	1.9	2.0	2.6	3.0	3.4	2.8	2.2	2.0	1.9	1.85
23	1.8	1.85	1.85	2.0	2.7	3.1	3.5	2.7	2.1	2.1	2.0	1.85
24	1.8	1.85	1.95	2.0	2.9	3.2	3.5	2.7	2.3	2.1	2.0	1.85
25	1.8	1.85	2.0	2.0	3.0	3.1	3.2	2.7	2.2	2.0	2.0	1.85
26	1.8	1.85	1.9	2.0	3.0	3.1	4.0	2.6	2.0	2.0	2.0	1.8
27	1.8	1.85	2.0	2.0	2.8	3.1	3.5	2.6	2.0	2.0	2.0	1.8
28	1.8	1.85	2.0	2.0	2.8	3.1	3.1	2.6	2.0	2.0	2.0	1.8
29	1.8	1.8	2.0	1.9	2.9	3.1	3.0	2.6	2.0	2.1	2.0	1.8
30	1.8	.....	2.0	2.0	2.9	3.1	3.0	2.6	2.0	2.0	2.0	1.85
31	1.8	.....	1.9	.....	2.9	.....	3.0	2.5	.....	2.0	.....	1.9

Rating table for Big Pine Creek near Big Pine, Cal., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.80	11	2.30	45	2.80	90	3.20	127
1.90	16	2.40	53	2.90	100	3.30	136
2.00	22	2.50	62	3.00	109	3.40	145
2.10	29	2.60	71	3.10	118	3.50	154
2.20	36	2.70	81				

Estimated monthly discharge of Big Pine Creek near Big Pine, Cal., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January	12	11	11	676
February	22	11	12	690
March	22	11	16.8	1,033
April	29	16	20.5	1,220
May	109	16	72.7	4,469
June	188	100	132	7,855
July	208	90	119	7,317
August	154	62	95.8	5,593
September	71	22	49	2,916
October	36	16	24	1,476
November	22	16	21	1,250
December	22	11	15	922
The year	208	11	49.1	35,417

MISCELLANEOUS MEASUREMENTS IN THE GREAT BASIN.

The following miscellaneous measurements were made in the Great Basin during 1903 and 1904:

Miscellaneous measurements in the Great Basin in 1903 and 1904.

WILLOW CREEK DRAINAGE BASIN IN CALIFORNIA.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1904.				*Sec.-feet.*
January 7	J. S. Evans	Willow Creek	Susanville	11.6
May 12	James Branham	do	do	9
August 16	S. G. Bennett and J. Y. Toler.	do	do	5.4
November 11	James Branham	do	Standish	52

Miscellaneous measurements in the Great Basin in 1903 and 1904—Continued.

OWENS RIVER DRAINAGE BASIN IN CALIFORNIA.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1903.				*Sec.-feet.*
July 30	R. S. Hawley	Hillside canal	At Bishop	3.8
Aug. 5	do	do	do	1.9
Aug. 15	do	do	do	2.3
Sept. 7	do	do	do	2.7
Sept. 15	do	do	do	2.9
Aug. 5	do	Love's ditch	do	.9
Aug. 15	do	do	do	.5
Sept. 5	do	do	do	1.5
Sept. 15	do	do	do	2.4
Oct. 10	do	McGee Creek	do	2.6
Oct. 10	do	Birch Creek	do	5.0
Oct. 12	do	Coyote Creek	do	1.6
Oct. 12	do	Mill Creek	At Big Pine	7.0
Aug. 14	do	Big Pine Creek	do	112
Oct. 12	do	do	do	16.4
Oct. 13	do	Birch Creek	At Fish Springs	3.5
Sept. 21	do	Fish Slough ditch	do	11.2
Oct. 13	do	Tinemaha Creek	do	3.6
Oct. 13	do	Taboose Creek	At Black Rock	4.8
Oct. 13	do	Clear Creek	do	1.7
Oct. 13	do	Goodale Creek	do	6.6
Oct. 13	do	Division Creek	Near Independence	2.5
Oct. 13	do	Oak Creek	do	10.7
Aug. 13	do	IndependenceCreek	At Independence	8.6
Sept. 17	do	do	do	4.5
Oct. 14	do	do	do	4.3
Oct. 14	do	Shepherd Creek	Near Independence	2.1
Oct. 14	do	Moffitt Creek	do	.3
Oct. 14	do	Georges Creek	do	.8
Oct. 15	do	Lone Pine Creek	At Lone Pine	3.3
Oct. 15	do	Tuttle Creek	Near Lone Pine	2.3
Oct. 31	do	Cottonwood Creek	Near Olancha	7.6
Oct. 31	do	Ash Creek	do	1.2
1904.				
Apr. 21	R. S. Hawley	Hillside canal	At Bishop	8.4
July 11	J. C. Clausen	do	do	5.0
Aug. 10	L. M. Barnes	do	do	6.3
Nov. 17	R. J. Taylor	do	do	11.5

Miscellaneous measurements in the Great Basin in 1903 and 1904—Continued.

OWENS RIVER DRAINAGE BASIN IN CALIFORNIA—Continued.

Date.	Hydrographer.	Stream.	Location.	Discharge.
1904.				*Sec.-feet.*
May 14	R. S. Hawley	Love's ditch	At Bishop	5.6
Apr. 21	do	do	do	4.2
July 11	J. C. Clausen	do	do	3.8
Apr. 1	R. S. Hawley	McGee Creek	do	3.8
Apr. 1	do	Birch Creek	do	4.8
Apr. 5	do	do	do	5.0
Apr. 4	do	Coyote Creek	do	2.0
Apr. 4	do	Mill Creek	At Big Pine	5.2
Apr. 5	do	Birch Creek	At Fish Springs	5.0
Apr. 5	do	Tinemaha Creek	do	4.0
Apr. 5	do	Taboose Creek	At Black Rock	4.2
Apr. 5	do	Clear Creek	do	6.4
Apr. 5	do	Goodale Creek	do	2.1
Apr. 5	do	Division Creek	At Black Rock Springs	2.5
Apr. 5	do	Oak Creek	At Independence	9.4
June 24	do	do	do	35
Apr. 5	do	IndependenceCreek	do	3.3
June 24	do	do	do	40
Dec. 19	R. J. Taylor	do	do	3.5
May 4	R. S. Hawley	Shepherd Creek	do	1.0
May 4	do	Georges Creek	do	2.4
May 4	do	Lone Pine Creek	At Lone Pine	4.0
June 10	do	do	do	28
May 5	do	Tuttle Creek	do	3.0
May 5	do	Cottonwood Creek	At Olancha	21
June 10	do	do	do	30
May 5	do	Ash Creek	do	3.0
June 18	J. C. Clausen	North Fork Bishop Creek.	At Bishop	81
Apr. 28	R. S. Hawley	Horton Creek	At Round Valley	5.0
Apr. 12	do	Hughes ditch	At Bishop	1.5
Oct. 1	do	do	do	.3
Oct. 10	do	do	do	3.0
Nov. 3	R. J. Taylor	do	do	2.2
Feb. 20	R. S. Hawley	Indian ditch	do	12.1

INDEX.

A. Page.

Adin, Cal.
Ash Creek at:
description 132
discharge..... 132
discharge, monthly 134
gage heights..... 133
rating table 133-134
Willow Creek near:
discharge..... 182
Alameda Creek at—
Niles dam, California:
discharge..... 181
Alameda Creek drainage:
miscellaneous measurements on creeks in..... 181
Alamitos, Cal.
San Gabriel River near—
discharge..... 84
Alamitos canal near—
Calexico, Cal.:
discharge..... 35
gage heights..... 36
Alamo channel near—
Calexico, Cal.:
discharge..... 33
gage heights..... 34
Alder Creek in—
Merced River basin:
discharge..... 185
Alturas, Cal.
E. Laner's ditch near:
discharge..... 182
Fitzhugh Creek near:
discharge..... 182
M. Hugh's ditch near:
discharge..... 182
Pit River at:
discharge..... 182
Alvord, Cal.
Sanger canal at:
description 240-241
discharge..... 241
gage heights..... 241-242
Amagusa Creek in—
Santa Yuez River basin, California:
discharge..... 77
American River near—
Fairoaks, Cal.:
description 145
discharge..... 146
gage heights..... 146

American River drainage, California: Page.
miscellaneous measurements on canals, ditches, and forks in 183
Antelope Creek in—
Klamath River drainage:
discharge..... 194
Red Bluff, Cal.:
discharge..... 182
Arroyo ditch in—
San Gabriel River drainage:
discharge..... 85-86
Arroyo Hondo near—
Sunol, Cal.:
discharge..... 181
Arroyo Seco, California, at and near—
miscellaneous points:
discharge..... 79
Soledad, Cal.:
description 48
discharge..... 49
discharge, monthly 50
gage heights..... 49
rating table 50
Ash Creek at—
Adin, Cal.:
description 132
discharge..... 132
discharge, monthly 134
gage heights 133
rating table 133-134
Ash Valley, California:
discharge..... 182
Olancha, Cal.:
discharge..... 260, 261
Ash Valley, California:
Ash Creek at:
discharge..... 182
Auburn, Cal.
American River (North and Middle forks) near:
discharge..... 183
Azusa, Cal.
San Gabriel canals near:
description 62
discharge..... 63
discharge, mean daily..... 64
discharge, monthly..... 65
San Gabriel River near:
description 62
discharge..... 63
discharge, monthly..... 65
gage heights..... 63
rating table..... 64

B. Page.

Bakersfield, Cal.
Kern River near:
description 176
discharge, mean daily..... 176
discharge, monthly..... 177
Baldwin ditch in—
San Gabriel River basin, California:
discharge..... 82-83
Balls Ferry, Cal.
Battle Creek near:
discharge..... 181
Bards station, California:
Sacramento River at:
discharge..... 181
Basin Slope Creek, California:
Tuolumne River (North Fork) above:
discharge..... 184
Battle Creek near—
Balls Ferry, Cal.:
discharge..... 181
Bear River above—
Wheatland, Cal.:
description 144
discharge..... 144
gage heights..... 145
Best's camp, Mexico:
Imperial canal (main) near:
discharge..... 41
Padrone River diversion at:
discharge..... 41
Bieber, Cal.
Pit River near:
description 134-135
discharge..... 135
discharge, monthly..... 137
gage heights..... 136
rating table..... 136
Big Creek at—
Summerdale, Cal.:
discharge..... 185
Big Pine, Cal.
Big Pine Creek near:
description 257
discharge..... 257, 260
discharge, monthly 259
gage heights..... 258
rating table 258
Mill Creek at:
discharge..... 260, 261
Big Pine and Owens River canal near—
Bishop, Cal.:
description 238
discharge..... 238
discharge, monthly 240
gage heights..... 238-239
rating table 240
Big Pine Creek near—
Big Pine, Cal.:
description 257
discharge..... 257, 260
discharge, monthly 259
gage heights..... 258
rating table 258
Big Tejunga Creek in—
Los Angeles River basin, California:
discharge..... 78

Birch Creek at— Page.
Bishop, Cal.:
discharge..... 260, 261
Fish Springs, Cal.:
discharge..... 260, 261
Bishop, Cal.
Big Pine and Owens River canal near:
description 238
discharge..... 238
discharge, monthly 240
gage heights..... 238-239
rating table 240
Birch Creek at:
discharge..... 260, 261
Bishop Creek near:
description 225
discharge..... 226
discharge, monthly 228
gage heights..... 226-227
rating table 228
Bishop Creek (North Fork) at:
discharge..... 261
Bishop Creek canal near:
description 214
discharge..... 214
discharge, monthly 216
gage heights..... 215
rating table 216
Collins's (A. O.) canal near:
description 232
discharge..... 232
discharge, monthly 235
gage heights..... 233-234
rating table 234
Collins's (George) canal near:
description 222
discharge..... 222
discharge, monthly..... 225
gage heights..... 223-224
rating table 224
Coyote Creek at:
discharge..... 260, 261
Dell canal near:
description 235
discharge..... 235-236
discharge, monthly..... 237
gage heights 236-237
Farmers' canal near:
description 216
discharge..... 217
discharge, monthly..... 219
gage heights 217-218
rating table 219
Hillside canal at:
discharge..... 260
Hughes's ditch at:
discharge..... 261
Indian ditch at:
discharge..... 261
Love's ditch at:
discharge..... 260, 261
McGee Creek at:
discharge..... 260, 261
McNally canal near:
description 219-220
discharge..... 220
discharge, monthly..... 221

Bishop, Cal.—Continued. Page.
McNally canal near:
gage heights 220-221
rating table 221
North Hillside canal near:
description 255
discharge 255
discharge, monthly 256
gage heights 256
rating table 256
Owens River canal near:
description 211
discharge 211
discharge, monthly 213
gage heights 212
rating table 213
Powers canal near:
description 251-252
discharge 252
discharge, monthly 253
gage heights 252
rating table 252
Rawson canal near:
description 229
discharge 229
discharge, monthly 231
gage heights 230-231
rating table 231
South Hillside canal near:
description 253
discharge 253
discharge, monthly 255
gage heights 254
rating table 254
Bishop Creek near—
Bishop, Cal.:
description 225
discharge 226
discharge, monthly 228
gage heights 226-227
rating table 228
Bishop Creek (North Fork) at—
Bishop, Cal.:
discharge 261
Bishop Creek canal near—
Bishop, Cal.:
description 214
discharge 214
discharge, monthly 216
gage heights 215
rating table 216
Black Rock, Cal.
Clear Creek at:
discharge 260, 261
Goodale Creek at:
discharge 260, 261
Taboose Creek at:
discharge 260, 261
Black Rock Springs, Cal.
Division Creek at:
discharge 261
Blue Canyon Creek in—
Santa Ynez River basin, California:
discharge 77
Boundary canal near—
Calexico, Cal.:
discharge 39
Bridal Veil Creek in— Page.
Yosemite Valley, California:
discharge 185
Bull Run Creek, California, above—
mouth:
discharge 188
Burney Creek, California—
below Burney Falls:
discharge 183
Pit River above:
discharge 183
Burney Falls, California:
Burney Creek below:
discharge 183
Butte Creek in—
Klamath River basin:
discharge 194

C.

Cache Creek at and near—
Lower Lake, Cal.:
description 109-110
discharge 110-111
discharge, monthly 112
gage heights 111
rating table 112
Yolo, Cal.:
description 113
discharge 113
discharge, monthly 115
gage heights 114
rating table 115
Calabasas, Cal.
Malibu Creek near:
description 58-59
discharge, monthly 60
gage heights 59
rating table 60
Triumfo Creek near:
description 58-59
discharge, monthly 62
gage heights 61
rating table 61
Calexico, Cal.
Alamitos canal near:
discharge 35
gage heights 36
Alamo channel:
discharge 33
gage heights 34
Boundary canal:
discharge 39
Hemlock canal near:
discharge 31
gage heights 32
Holt canal near:
discharge 29-30
gage heights 30
Imperial canal (main) near:
discharge 37
gage heights 38
New River at:
discharge 41
California-Mexico boundary line.
Imperial canal at:
description 26-27
discharge 27, 28
gage heights 28

Page.
Canby, Cal.
Pit River near:
description 128–129
discharge 129
discharge, monthly 131
gage heights 130
rating table 131
Canyon Creek near—
Centerville, Cal.:
discharge 182
Carbon, Cal.
Hat Creek at:
discharge 183
Carmelita, Cal.
'76 canal near:
discharge 186
Carter River, Mexico—
Imperial canal at:
discharge 41
Carter-Lake Eleanor trail crossing, California:
Cherry River at:
discharge 184
Clavey River at:
discharge 184
Hull Creek at:
discharge 184
Centerville, Cal.
Canyon Creek near:
discharge 182
Cherry River at—
Carter-Lake Eleanor trail crossing, California:
discharge 184
Chino Creek near—
Rincon, Cal.:
discharge 94
Chiquita San Joaquin River, California, at—mouth:
discharge 185
Citrus, Cal.
East Side canal near:
description 242–243
discharge 243
discharge, monthly 245
gage heights 243–244
rating table 245
Owens River near:
description 248
discharge 249
discharge, monthly 251
gage heights 249–250
rating table 251
Stevens canal near:
description 245
discharge 246
discharge, monthly 248
gage heights 246–247
rating table 247–248
City Creek in—
Santa Ana River basin, California:
discharge 89
Clark Creek, California:
discharge 187
Clavey River above—
Twomile Creek, California:
discharge 184

Page.
Clear Creek at—
Black Rock, Cal.:
discharge 260, 261
Clear Lake, Cal.
Lost River at:
discharge 188
gage heights 189
Clear Lake at—
Lakeport, Cal.:
evaporation record 19
Clearwater, Cal.
Los Angeles River near:
discharge 79
Clements, Cal.
Mokelumne River near:
description 150
discharge 151
gage heights 151
Collins's (A. O.) canal near—
Bishop, Cal.:
description 232
discharge 232
discharge, monthly 235
gage heights 233–234
rating table 234
Collins's (George) canal near—
Bishop, Cal.:
description 222
discharge 222
discharge, monthly 225
gage heights 223–224
rating table 224
Colorado River at—
Yuma, Ariz.:
description 20–21
discharge 21–24
discharge, monthly 25
evaporation 26
gage heights 25
Colorado River drainage basin:
description 19–20
miscellaneous measurements on canals and rivers 41
Colorado Valley Pumping and Irrigation Company's canal, Ariz., at—
head:
discharge 41
Yuma, Ariz.:
cost of pumping 46
duty of water 42–44, 45
seepage loss 47
Cottonwood Creek at—
Olancha, Cal.:
discharge 260, 261
Coyote Creek at—
Bishop, Cal.:
discharge 260, 261
Cucamonga Creek in—
Santa Ana River basin, Cal.:
discharge 87

D.

Dalton Creek in—
San Gabriel River basin, Cal.:
discharge 81
Davis Creek at—
Davis Creek, Cal.:
discharge 182

Page.

Davis Creek, Cal.
  Davis Creek at:
    discharge 182
Deer Creek, near—
  Vina, Cal.:
    discharge 182
Dell canal near—
  Bishop, Cal.:
    description 235
    discharge 235-236
    discharge, monthly 237
    gage heights 236-237
Devils Gate, Cal.
  Arroyo Seco at and near:
    discharge 79
Division Creek at and near—
  Black Rock Springs, Cal.:
    discharge 261
  Independence, Cal.:
    discharge 260
Dorst Creek in—
  Kaweah River basin:
    discharge 186
Downey, Cal.
  Rio Hondo, near:
    discharge 84

E.

East Side canal near—
  Citrus, Cal.:
    description 242-243
    discharge 243
    discharge, monthly 245
    gage heights 243-244
    rating table 245
East Twin Creek in—
  Santa Ana River basin, California:
    discharge 88-89
Eaton Canyon Creek in—
  San Gabriel River basin, California:
    discharge 83
Eel River at—
  Stingleys Station, Cal.:
    discharge 196
El Monte, Cal.
  San Gabriel River at:
    discharge 83-84
  Whittier ditch near:
    discharge 86
Eleanor Creek below—
  Lake Eleanor, California:
    discharge 184
Electra, Cal.
  Mokelumne River at:
    description 148
    discharge 148
    discharge, monthly 150
    gage heights 149
    rating table 149
Esperanza, Cal.
  Anaheim and Fullerton canal at:
    discharge 92
  Piru Creek near:
    discharge 76
  Yorba ditch at:
    discharge 92

F.

Page.

Fairoaks, Cal.
  American River near:
    description 145
    discharge 146
    gage heights 146
Fall River near—
  Fallriver Mills, Cal.:
    discharge 183
Fallriver Mills, Cal.
  Fall River near:
    discharge 183
Farmers' canal, Arizona, at and near—
  head:
    discharge 41
  Bishop, Cal.:
    description 216
    discharge 217
    discharge, monthly 219
    gage heights 217-218
    rating table 219
Feather River at—
  Oroville, Cal.:
    description 137-138
    discharge 138
    discharge, monthly 140
    gage heights 138-139
    rating table 139
Fish Springs, Cal.
  Birch Creek at:
    discharge 260, 261
  Tinemaha Creek at:
    discharge 260, 261
Fitzhugh Creek near—
  Alturas, Cal.:
    discharge 182
Folsom, Cal.
  American River (South Fork) near:
    discharge 183
  North Fork ditch near:
    discharge 183
Fort Klamath, Oreg.
  Wood River at:
    discharge 195
Fruto, Cal.
  Stony Creek near:
    description 116
    discharge 116
    discharge, monthly 118
    gage heights 117
    rating table 117

G.

Georges Creek at—
  Independence, Cal.:
    discharge 260, 261
Goodale Creek at—
  Black Rock, Cal.:
    discharge 260, 261
Grangeville, Cal.
  King River (lower) canal at:
    discharge 186
Great Basin drainage:
  description 196
  miscellaneous measurements on canals, creeks, and ditches 259-261

Page.
Gregory, Cal.
McCloud River near:
description 122
discharge 123
gage heights 123
Guenoc, Cal.
Puta Creek near:
description 106-107
discharge 107
discharge, monthly 108
gage heights 107
rating table 108

H.

Hat Creek at—
Carbon, Cal.:
discharge 183
Hatchet Creek near—
Montgomery, Cal.:
discharge 183
Healdsburg, Cal.
Russian River at:
discharge 196
Hemlock canal near—
Calexico, Cal.:
discharge 31
gage heights 32
Herndon, Cal.
San Joaquin River at:
description 165-166
gage heights 166
Hetch Hetchy Valley, California.
Rancheria Creek in:
discharge 184
Tiltill Creek in:
discharge 184
Tuolumne River in:
discharge 184
Hillside canal at—
Bishop, Cal.:
discharge 260
Hollister, Cal.
San Benito River near:
discharge 196
Holt canal near—
Calexico, Cal.:
discharge 29-30
gage heights 30
Horton Creek at—
Round Valley, Cal.:
discharge 261
Hughes ditch at—
Bishop, Cal.:
discharge 261
Hull Creek at—
Carter-Lake Eleanor trail crossing, California:
discharge 184

I.

Illilouette Creek in—
Yosemite Valley, Cal.:
discharge 184
Imperial canal at and near—
Best's camp, Mexico:
discharge 41
Calexico, Cal.:
discharge 37
gage heights 38

Page.
Imperial canal at and near—
California-Mexico boundary line:
description 26-27
discharge 27, 28
gage heights 28
junction with Carter River, Mexico:
discharge 41
Imperial Valley, Cal.
waste measurements in 40
Imperial Valley canals:
description 29
Independence, Cal.
Division Creek near:
discharge 260
Georges Creek near:
discharge 260, 261
Independence Creek at:
discharge 260, 261
Moffitt Creek near:
discharge 260
Oak Creek at:
discharge 260, 261
Shepherd Creek at:
discharge 260, 261
Independence Creek at—
Independence, Cal.:
discharge 260, 261
Isabella, Cal.
Kern River and ditches near:
discharge 188
Ives ditch. *See* Colorado Valley Pumping and Irrigation Company's canal.
Ivy, Cal.
Pit River (South Fork) near:
description 125-126
discharge 126
discharge, monthly 128
gage heights 127
rating table 127-128

J.

Jackson Creek, Cal.:
discharge 188

K.

Kaweah River below—
Three Rivers, Cal.:
description 170-171
discharge 171
discharge, monthly 173
gage heights 172
rating table 172
Kaweah River (East Fork) in—
California:
discharge 187
Kaweah River (Marble Fork) in—
Sequoia Park, Cal.:
discharge 187
Kaweah River (Middle Fork) in—
California:
discharge 187
Kaweah River (North Fork) above—
Schreibers ditch:
discharge 186
Three Rivers, Cal.:
discharge 186
Kaweah River drainage:
miscellaneous measurements on rivers and creeks 186-187

Page.
Keno, Oreg.
Klamath River at:
discharge..... 190
gage heights..... 191
Kern River near—
Bakersfield, Cal.:
description..... 176
discharge, mean daily..... 176
discharge, monthly..... 177
Isabella, Cal.:
discharge..... 188
Kern River (North Fork) near—
Kernville, Cal.:
discharge..... 187, 188
Kern River (South Fork) near—
Isabella, Cal.:
discharge..... 188
Kern River drainage:
miscellaneous measurements on rivers, creeks, and ditches..... 187-188
Kernville, Cal.
Kern River (North Fork) and ditches at and near:
discharge..... 188
King River, Cal.
canals and ditches near:
discharge..... 185
King River at and near—
Kingsburg, Cal.:
description..... 169
gage heights..... 170
mouth of North Fork:
discharge..... 185
Sanger, Cal.:
description..... 167
discharge..... 167
discharge, monthly..... 169
gage heights..... 168
rating table..... 168
King River (North Fork) at—
mouth:
discharge..... 185
King River drainage:
miscellaneous measurements on canals and ditches..... 185-186
Kingsburg, Cal.
Ditches near:
discharge..... 186
King River at:
description..... 169
gage heights..... 170
Klamath Falls, Oreg.
Ankney canal at:
discharge..... 195
Klamath River at:
discharge..... 191
gage heights..... 192
Klamath Lake (Upper). *See* Upper Klamath Lake.
Klamath River at—
Keno, Oreg.:
discharge..... 190
gage heights..... 191
Klamath Falls, Oreg.:
discharge..... 191
gage heights..... 192
Klamathon, Cal.:
discharge..... 194
Klamath River drainage: Page.
miscellaneous measurements on rivers, creeks, canals, and ditches..... 194-195
Klamathon, Cal.
Klamath River at:
discharge..... 194
Knights Ferry, Cal.
Schell ditch at:
discharge..... 183
Stanislaus River at:
description..... 151-152
discharge..... 152
discharge, monthly..... 154
gage heights..... 153
rating table..... 153
Stanislaus Water Company's ditch at:
description..... 154
discharge..... 155, 183
gage heights..... 155
rating table..... 156

L.

Lagrange, Cal.
Modesto canal at:
description..... 161
discharge..... 162
discharge, monthly..... 158
gage heights..... 162
rating table..... 163
Tuolumne River at:
description..... 156
discharge..... 157
discharge, monthly..... 158
gage heights..... 157
rating table..... 158
Turlock canal at:
description..... 159
discharge..... 159
discharge, monthly..... 158
gage heights..... 160
rating table..... 160-161
Lagrange dam, Cal.
mining ditch near:
discharge..... 184
Lake Eleanor, Cal.
Eleanor Creek near:
discharge..... 184
Lakeport, Cal.
Clear Lake at:
evaporation record..... 109
Langells Valley, Oreg.
Lost River at:
discharge..... 195
Lasalle ranch at—
Yuma, Ariz.:
duty of water..... 44
Laton, Cal.
canals and ditches at:
discharge..... 186
Likely, Cal.
Corporation ditch near:
discharge..... 182
Dukes ditch near:
discharge..... 182
West Valley Creek near:
description..... 123-124
discharge..... 124
gage heights..... 125

Page.
Little Anita Creek in—
San Gabriel River basin, Cal.:
discharge..... 83
Little Kern River, Cal.:
discharge..... 187
Little Shasta River at—
Table Rock, Cal.:
discharge..... 195
Little Tejunga Creek in—
Los Angeles River basin, Cal.:
discharge..... 78
Lone Pine, Cal.
Lone Pine Creek at:
discharge..... 260, 261
Tuttle Creek at:
discharge..... 260, 261
Lone Pine Creek at—
Lone Pine, Cal.:
discharge..... 260, 261
Lorella, Oreg.
Miller Creek near:
discharge..... 189, 195
gage heights..... 189
Los Angeles, Cal.
Arroyo Seco at:
discharge..... 79
Los Angeles River at and near:
discharge..... 78–79, 80–81
Los Angeles River at and near—
Los Angeles, Cal.:
discharge..... 78–79, 80–81
Los Angeles River drainage:
miscellaneous measurements on rivers and creeks..... 78–81
ost River at—
Clear Lake, Cal.
discharge..... 188
gage heights..... 189
Langells Valley, Oreg.:
discharge..... 195
Merrill, Oreg.:
discharge..... 190
gage heights..... 190
Olene, Oreg.:
discharge..... 195
Love's ditch at—
Bishop, Cal.:
discharge..... 260–261
Lower Lake, Cal.
Cache Creek at:
description..... 109–110
discharge..... 110–111
discharge, monthly..... 112
gage heights..... 111
rating table..... 112
Ludy canal, Ariz.
at head:
discharge..... 41
Lytle Creek in—
Santa Ana River basin, Cal.:
discharge..... 87, 88

M.

McCloud River near—
Gregory, Cal.:
description..... 122
discharge..... 123
gage heights..... 123

Page.
McGee Creek at—
Bishop, Cal.:
discharge..... 260, 261
McNally canal near—
Bishop, Cal.:
description..... 219–220
discharge..... 220
discharge, monthly..... 221
gage heights..... 220–221
rating table..... 221
Mad River at—
Vance, Cal.:
discharge..... 195
Malibu Creek near—
Calabasas, Cal.:
description..... 58–59
discharge, monthly..... 60
gage heights..... 59
rating table..... 60
Mentone, Cal.
Santa Ana River near:
description..... 67
discharge..... 68
discharge, monthly..... 69
rating table..... 69
Merced Falls, Cal.
Merced River above:
description..... 163
discharge..... 163–164
discharge, monthly..... 165
gage heights..... 164
rating table..... 165
Merced River above—
Merced Falls, Cal.:
description..... 163
discharge..... 163–164
discharge, monthly..... 165
gage heights..... 164
rating table..... 165
in Yosemite Valley, California:
description..... 178
discharge..... 178, 184
gage heights..... 179
Merced River (South Fork):
ditches on:
discharge..... 185
near Wawona Bridge, California:
discharge..... 185
Merced River drainage:
miscellaneous measurements on rivers, creeks, and ditches..... 184–185
Merrill, Oreg.
Adams ditch at:
discharge..... 195
Lost River at:
discharge..... 190
gage heights..... 190
Tule Lake near:
gage heights..... 194
Merrillville, Cal.
Willow Creek at:
description..... 199
discharge..... 199
discharge, monthly..... 200
gage heights..... 199–200
Mill Creek at and near—
Big Pine, Cal.:
discharge..... 260, 261

Page.
Mill Creek at and near—
in Santa Ana River basin, California:
discharge 89-90
Tehama, Cal.:
discharge 182
Miller Creek near—
Lorella, Oreg.:
discharge 189, 195
gage heights 189
Mineral King, Cal.
Kaweah River (East Fork) at:
discharge 187
Modesto canal at—
Lagrange, Cal.:
description 161
discharge 162
discharge, monthly 158
gage heights 162
rating table 163
Moffitt Creek near—
Independence, Cal.:
discharge 260
Mohave River at—
Victorville, Cal.:
description 72
discharge 73
discharge, monthly 74
Mokelumne River at and near—
Clements, Cal.:
description 150
discharge 151
gage heights 151
Electra, Cal.:
description 148
discharge 148
discharge, monthly 150
gage heights 149
rating table 149
Mono Creek at—
Mono dam site, California:
description 55-56
discharge 56
discharge, monthly 58
gage heights 57
rating table 57
Mono dam site, California:
Mono Creek at:
description 55-56
discharge 56
discharge, monthly 58
gage heights 57
rating table 57
Montgomery, Cal.
Hatchet Creek near:
discharge 183
Montgomery Creek at:
discharge 183
Montgomery Creek at—
Montgomery, Cal.:
discharge 183

N.

Nameless Creek, California:
discharge 187
New River at—
Calexico, Cal.:
discharge 41

Page.
Niles dam, California.
Alameda Creek at:
discharge 181
North Hillside canal near—
Bishop, Cal.:
description 255
discharge 255
discharge, monthly 256
gage heights 256
rating table 256
Northern Pacific Ocean drainage:
miscellaneous measurements on rivers in 195-196

O.

Oak Creek at—
Independence, Cal:
discharge 260, 261
Olancha, Cal.
Ash Creek at:
discharge 260, 261
Cottonwood Creek at:
discharge 260, 261
Olene Oreg.
Lost River at:
discharge 195
Olive, Cal.
Santa Ana River at:
discharge 94
Oroville, Cal.
Feather River at:
description 137-138
discharge 138
discharge, monthly 140
gage heights 138-139
rating table 139
Owens River near—
Citrus, Cal.:
description 248
discharge 249
discharge, monthly 251
gage heights 249-250
rating table 251
Round Valley, California:
description 200
discharge 201
discharge, monthly 203
gage heights 202
rating table 203
Owens River drainage, California:
miscellaneous measurements on creeks, canal, and ditches 260-261
Owens River canal near—
Bishop, Cal.:
description 211
discharge 211
discharge, monthly 213
gage heights 212
rating table 213

P.

Pacoima Creek in—
Los Angeles River basin, California:
discharge 78
Padrone River diversion at—
Best's camp, Mexico:
discharge 41
Pajaro River drainage:
miscellaneous measurements on rivers. 196

Page.
Pala, Cal.
San Luis Rey River near:
description 65-66
discharge 78
gage heights 66
Pasadena, Cal.
Arroyo Seco at:
discharge 79
Pelican, Oreg.
Upper Klamath Lake near:
gage heights 193
Pine Creek, Cal.
Pine Creek near:
discharge 182
Pine Creek near—
Pine Creek, Cal.:
discharge 182
Round Valley, Cal.:
description 207
discharge 208
discharge, monthly 210
gage heights 208-209
rating table 210
Piru Creek in—
Santa Clara River basin, Cal.:
discharge 76
Pit River at and near—
Alturas, Cal.:
discharge 182
Bieber, Cal.:
description 134-135
discharge 135
discharge, monthly 137
gage heights 136
rating table 136
Burney Creek, Cal.:
discharge 183
Canby, Cal.:
description 128-129
discharge 129
discharge, monthly 131
gage heights 130
rating table 131
Pitville, Cal.:
discharge 182
Pit River (South Fork) near—
Ivy, Cal.:
description 125-126
discharge 126
discharge, monthly 128
gage heights 127
rating table 127-128
Pit River drainage, California:
miscellaneous measurements on creeks and ditches 182-183
Pitville, Cal.
Pit River at:
discharge 182
Plunge Creek in—
Santa Ana River basin, Cal.:
discharge 89
Portersville, Cal.
Tule River near:
description 173
discharge 174
discharge, monthly 175
gage heights 174
rating table 175
Powers canal near—
Bishop, Cal.:
description 251-252
discharge 252
discharge, monthly 253
gage heights 252
rating table 252
Puta Creek near—
Guenoc, Cal.:
description 106-107
discharge 107
discharge, monthly 108
gage heights 107
rating table 108

R.

Rancheria Creek in—
Hetch Hetchy Valley, Cal.:
discharge 184
Rawson canal near—
Bishop, Cal.:
description 229
discharge 229
discharge, monthly 231
gage heights 230-231
rating table 231
Red Bluff, Cal.
Antelope Creek near:
discharge 182
Sacramento River near:
description 118-119
discharge 119
discharge, monthly 122
gage heights 120
rating table 121
Reed Creek at—
Rasasco ranch, Cal.:
discharge 184
Rialto canal in—
Santa Ana River basin, Cal.:
discharge 87, 88
Rinçon, Cal.
Chino Creek near:
discharge 94
Rio Hondo in—
San Gabriel River basin, Cal.:
discharge 84
Rivera, Cal.
Arroyo ditch at:
discharge 86
Rio Hondo near:
discharge 84
San Gabriel River at:
discharge 84
Rock Creek near—
Round Valley, Cal.:
description 204
discharge 204
discharge, monthly 207
gage heights 205-206
rating table 206
Rose ranch at—
Yuma, Ariz.:
duty of water 45
Round Valley, Cal.
Horton Creek at:
discharge 261

Round Valley, Cal.—Continued. Page.
Owens River near:
description 200
discharge 201
discharge, monthly 203
gage heights 202
rating table 203
Pine Creek near:
description 207
discharge 208
discharge, monthly 210
gage heights 208-209
rating table 210
Rock Creek near:
description 204
discharge 204
discharge, monthly 207
gage heights 205-206
rating table 206
Rush Creek at:
discharge 182
Ruiz Creek in—
Santa Ynez River basin, Cal.:
discharge 77
Rush Creek at—
Round Valley, Cal.:
discharge 182
Russian River at—
Healdsburg, Cal.:
discharge 196

S.

Sacramento, Cal.
Sacramento River at:
gage heights 146-147
turbidity record 147
Sacramento River at and near—
Bards station, California:
discharge 181
Redbluff, Cal.:
description 118-119
discharge 119
discharge, monthly 122
gage heights 120
rating table 121
Sacramento, Cal.:
gage heights 146-147
turbidity record 147
Sacramento River drainage:
miscellaneous measurements on creeks and canals 181-182
Salmon Creek, California, at—
mouth:
discharge 188
San Antonio Creek—
at division point, California:
weir measurements 95
in Santa Ana River basin, California:
discharge 86-87
San Antonio tunnel at—
the Portal, California:
discharge 96
San Benito River near—
Hollister, Cal.:
discharge 196
San Bernardino Valley, California:
return waters 102-103
San Dimas Creek in— Page.
San Gabriel River basin, Cal.:
discharge 82
San Francisco Bay drainage basin:
description 103-106
miscellaneous measurements on rivers, creeks, canals, and ditches ... 181-188
San Francisquito Creek in—
Santa Clara River basin, Cal.:
discharge 75
San Gabriel canals near—
Azusa, Cal.:
description 62
discharge 63
discharge, mean daily 64
discharge, monthly 65
San Gabriel River at and near—
Alamitos, Cal.:
discharge 84
Azusa, Cal.:
description 62
discharge 63
discharge, monthly 65
gage heights 63
rating table 64
Elmonte, Cal.:
discharge 83-84
Rivera, Cal.:
discharge 84
Studebaker, Cal.:
discharge 84
San Gabriel River drainage basin:
miscellaneous measurements on rivers, creeks, and ditches in 81-86
San Joaquin River, California—
at Herndon, Cal.:
description 165-196
gage heights 166
below mouth of Chiquita San Joaquin:
discharge 185
San Joaquin River drainage:
miscellaneous measurements on rivers and ditches 185
San Jose Creek in—
San Gabriel River basin, California:
discharge 84
San Luis Rey River at and near—
dam site, Warner's ranch reservoir, California:
discharge 78
head of Escondido canal:
discharge 78
Pala, Cal.:
description 65-66
discharge 78
gage heights 66
San Luis Rey River drainage:
miscellaneous measurements on rivers and canals 78
Sanger, Cal.
King River near:
description 167
discharge 167
discharge, monthly 169
gage heights 168
rating table 168
Newhall ditch near:
discharge 75

Page.
Sanger canal at—
Alvord, Cal.:
description 240-241
discharge 241
gage heights 241-242
Santa Ana River at and near—
Mentone, Cal.:
description 67
discharge 68
discharge, monthly 69
rating table 69
miscellaneous points:
discharge 92-93
Yorba, Cal.:
discharge 93
Santa Ana River drainage, California:
miscellaneous measurements on rivers, creeks, canals, and ditches 86-94
return waters 97-101
Santa Anita Creek in—
San Gabriel River basin, California:
discharge 82, 83
Santa Barbara, Cal.
Santa Ynez River near:
description 51
discharge 52-54
discharge, monthly 55
gage heights 54
rating table 55
Santa Clara River basin, California:
miscellaneous measurements on rivers, creeks, canals, and ditches 75-77
Piru Creek in:
discharge 76
Sespe Creek and canal in:
discharge 77
Santa Maria, Cal.
Santa Maria River near:
description 70
discharge 70
discharge, monthly 72
gage heights 71
rating table 71
Santa Maria River near—
Santa Maria, Cal.:
description 70
discharge 70
discharge, monthly 72
gage heights 71
rating table 71
Santa Maria River drainage:
miscellaneous measurements on rivers. 74
Santa Paula, Cal.
Santa Clara River and ditches near:
discharge 75-76
Santa Paula Creek at and near:
discharge 77
Santa Paula Creek at and near—
Santa Paula, Cal.:
discharge 77
Santa Ynez River near—
Santa Barbara, Cal.:
description 51
discharge 52-54
discharge, monthly 55
gage heights 54
rating table 55
Santa Ynez River drainage:
miscellaneous measurements on creeks. 77

Page.
Schell ditch at—
Knights Ferry, Cal.:
discharge 183
Seabright, Cal.
Los Angeles River near:
discharge 79
Sequoia, Cal.
Tuolumne River (Middle Fork) near:
discharge 184
Tuolumne River (South Fork) near:
discharge 184
Sequoia Park, Cal.
Kaweah River (Marble Fork) in:
discharge 187
Sespe Creek and canal in—
Santa Clara River basin, California:
discharge 77
Shepherd Creek at—
Independence, Cal.:
discharge 260, 261
Sickler's canal at—
Sickler's ranch, California:
discharge 78
Sisquoc River at—
Sisquoc ranch, California:
discharge 74
Smartsville, Cal.
Yuba River near:
description 140-141
discharge 141
discharge, monthly 143
gage heights 142
rating table 143
Soda Creek, California, above—
Mouth:
discharge 187
Soledad, Cal.
Arroyo Seco near—
description 48
discharge 49
discharge, monthly 50
gage heights 49
rating table 50
South Hillside canal near—
Bishop, Cal.:
description 253
discharge 253
discharge, monthly 255
gage heights 254
rating table 254
Southern California drainage:
description 47-48
Sprague River near—
Yainax, Oreg.:
gage heights 195
Standish, Cal.
Willow Creek at:
discharge 259
Stanford canal near—
Vina, Cal.:
discharge 181
Stanislaus River at—
Knights Ferry, Cal.:
description 151-152
discharge 152
discharge, monthly 154
gage heights ..... 1[illegible]
rating table ..... 1[illegible]

Page.
Stanislaus River drainage:
miscellaneous measurements on ditches 183
Stanislaus Water Company's ditch at—
Knights Ferry, Cal.:
description 154
discharge 155, 183
gage heights 155
rating table 156
Stevens canal near—
Citrus, Cal.:
description 245
discharge 246
discharge, monthly 248
gage heights 246-247
rating table 247-248
Stony Creek, California—
in Kaweah River basin:
discharge 186
near Fruto, Cal.:
description 116
discharge 116
discharge, monthly 118
gage heights 117
rating table 117
Studebaker, Cal.
San Gabriel River at:
discharge 84
Summerdale, Cal.
Big Creek at:
discharge 185
Sunol, Cal.
Arroyo Hondo near:
discharge 181
Susan River near—
Susanville, Cal.:
description 197
discharge 197
discharge, monthly 198
gage heights 198
Susanville, Cal.
Susan River near:
description 197
discharge 197
discharge, monthly 198
gage heights 198
Willow Creek at:
discharge 259

T.

Table Rock, Cal.
Little Shasta River at:
discharge 195
Taboose Creek at—
Black Rock, Cal.:
discharge 260, 261
Tehama, Cal.
Mill Creek near:
discharge 1>2
Tenaya Creek at—
Yosemite Valley, California:
description 179-184
discharge 179
gage heights 180
Three Rivers, Cal.
Kaweah River below:
description 170-171
discharge 171
discharge, monthly 173
gage heights 172
Three Rivers, Cal.—Continued. Page.
Kaweah River below—Continued.
rating table 172
Kaweah River (North Fork) above:
discharge 186
Tiltill Creek in—
Hetch Hetchy Valley, California:
discharge 184
Tinemaha Creek at—
Fish Springs, Cal.:
discharge 26, 261
Tobias Creek, California:
at mouth:
discharge 188
Trail Creek in—
Santa Ynez River basin, Cal.:
discharge 77
Triumfo Creek near—
Calabasas, Cal.:
description 58-59
discharge, monthly 62
gage heights 61
rating table 61
Tule Lake near—
Merrill, Oreg.:
gage heights 194
Tule River near—
Portersville, Cal.:
description 173
discharge 174
discharge, monthly 175
gage heights 174
rating table 175
Tule River (South Fork), California, near—
mouth:
discharge 187
Tule River drainage:
miscellaneous measurements on rivers. 187
Tuolumne River at—
Lagrange, Cal.:
description 156
discharge 157
discharge, monthly 158
gage heights 157
rating table 158
in Hetch Hetchy Valley, Cal.:
discharge 184
Tuolumne River (Middle Fork) near—
Sequoia, Cal.:
discharge 184
Tuolumne River (North Fork) above—
Basin Slope Creek, California:
discharge 184
Tuolumne River (South Fork) near—
Sequoia, Cal.:
discharge 184
Tuolumne River drainage:
miscellaneous measurements on rivers, creeks, and ditches 184
Turlock canal at—
Lagrange, Cal.:
description 159
discharge 159
discharge, monthly 158
gage heights 160
rating table 160-161
Tuttle Creek at—
Lone Pine, Cal.:
discharge 260, 261

Page.

Twomile Creek, Cal., at—
mouth:
discharge..... 184

U.

Upper Klamath Lake near—
Pelican, Oreg.:
gage heights..... 193

V.

Vance, Cal.
Mad River at:
discharge..... 195
Ventura River near—
Ventura, Cal.:
discharge..... 74
Ventura River drainage:
miscellaneous measurements on rivers and canals..... 71
Victorville, Cal.
Mohave River at:
description..... 72
discharge..... 73
discharge, monthly..... 74
Vina, Cal.
Deer Creek near:
discharge..... 182
Stanford canal near:
discharge..... 181

W.

Wade Creek, California:
discharge..... 188
West Twin Creek in—
Santa Ana River basin, California:
discharge..... 88
West Valley Creek near—
Likely, Cal.:
description..... 123-124
discharge..... 124
gage heights..... 125
Wheatland, Cal.
Bear River above:
description..... 144
discharge..... 144
gage heights..... 145
Wheatville, Cal.
Crescent canal near:
discharge..... 186
Williamson River in—
Klamath River basin:
discharge..... 195
Willow Creek at and near—
Adin, Cal.:
discharge..... 182
Merrillville, Cal.:
description..... 199
discharge..... 199
discharge, monthly..... 200
gage heights..... 199-200
Susanville, Cal.:
discharge..... 259
Standish, Cal.:
discharge..... 259
Willow Creek drainage:
miscellaneous measurements on creeks. 259

Page.

Wood River at—
Fort Klamath, Oreg.:
discharge..... 195
Workman, Cal.
Rio Hondo near:
discharge..... 84

Y.

Yainax, Oreg.
Sprague River near:
gage heights..... 196
Yolo, Cal.
Cache Creek near:
description..... 113
discharge..... 113
discharge, monthly..... 115
gage heights..... 114
rating table..... 115
Yorba, Cal.
Santa Ana River near:
discharge..... 98
Yosemite Creek at—
Yosemite Valley, California:
description..... 180
discharge..... 180, 184-185
gage heights..... 181
Yosemite Valley, California:
description of stations in..... 177-178
miscellaneous measurements on creeks..... 184-185
Merced River in:
description..... 178
discharge..... 178
gage heights..... 179
Tenaya Creek at:
description..... 179
discharge..... 179
gage heights..... 180
Yosemite Creek at:
description..... 180
discharge..... 180
gage heights..... 181
Yuba River near—
Smartsville, Cal.:
description..... 140-141
discharge..... 141
discharge, monthly..... 143
gage heights..... 142
rating table..... 143
Yuma, Ariz.
Colorado River at:
description..... 20-21
discharge..... 21-24
discharge, monthly..... 25
evaporation..... 26
gage heights..... 25
Colorado Valley Pumping and Irrigation Company's canal at:
cost of pumping..... 46
duty of water..... 42-44, 45
seepage loss..... 47
Laselle ranch at:
duty of water..... 44
Rose ranch at:
duty of water..... 45

O

PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

[Water-Supply Paper No. 134.]

The publications of the United States Geological Survey consist of (1) Annual Reports; (2) Monographs; (3) Professional Papers; (4) Bulletins; (5) Mineral Resources; (6) Water-Supply and Irrigation Papers; (7) Topographic Atlas of United States, folios and separate sheets thereof; (8) Geologic Atlas of United States, folios thereof. The classes numbered 2, 7, and 8 are sold at cost of publication; the others are distributed free. A circular giving complete lists may be had on application.

Most of the above publications may be obtained or consulted in the following ways:

1. A limited number are delivered to the Director of the Survey, from whom they may be obtained, free of charge (except classes 2, 7, and 8), on application.

2. Every member of Congress is allotted a certain number, from whom they may be obtained, free of charge, on application.

3. Other copies are deposited with the Superintendent of Documents, Washington, D. C., from whom they may be had at practically cost.

4. Copies of all Government publications are furnished to the principal public libraries in the large cities throughout the United States, where they may be consulted by those interested.

The Professional Papers, Bulletins, and Water-Supply Papers treat of a variety of subjects, and the total number issued is large. They have therefore been classified into the following series: A, Economic geology; B, Descriptive geology; C, Systematic geology and paleontology; D, Petrography and mineralogy; E, Chemistry and physics; F, Geography; G, Miscellaneous; H, Forestry; I, Irrigation; J, Water storage; K, Pumping water; L, Quality of water; M, General hydrographic investigations; N, Water power; O, Underground waters; P, Hydrographic progress reports.

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1888. Tenth Annual Report, Part II.
1889. Eleventh Annual Report, Part II.
1890. Twelfth Annual Report, Part II.
1891. Thirteenth Annual Report, Part III.
1892. Fourteenth Annual Report, Part II.
1893 Bulletin No. 131.
1894. Bulletin No. 131; Sixteenth Annual Report, Part II.
1895. Bulletin No. 140.
1896. Water-Supply Paper No. 11; Eighteenth Annual Report, Part IV.
1897. Water-Supply Papers Nos. 15 and 16, Nineteenth Annual Report, Part IV.
1898. Water-Supply Papers Nos. 27 and 28, Twentieth Annual Report, Part IV.
1899. Water-Supply Papers Nos. 35, 36, 37, 38, and 39, Twenty-first Annual Report, Part IV.
1900. Water-Supply Papers Nos. 47, 48, 49, 50, 51, and 52; Twenty-second Annual Report, Part IV.
1901. East of Mississippi River, Water-Supply Papers Nos. 65 and 75.
West of Mississippi River, Water-Supply Papers Nos. 66 and 75.
1902. East of Mississippi River, Water-Supply Papers Nos. 82 and 83.
West of Mississippi River, Water-Supply Papers Nos. 84 and 85.

1903. East of Mississippi River, Water-Supply Papers Nos. 97 and 98.
West of Mississippi River, Water-Supply Papers Nos. 99 and 100.
1904. East of Mississippi River, Water-Supply Papers Nos. 124, 125, 126, 127, 128, and 129.
West of Mississippi River, Water-Supply Papers Nos. 130, 131, 132, 133, 134, and 135.

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AUGUST, 1905.

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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

REPORT

OF

PROGRESS OF STREAM MEASUREMENTS

FOR

THE CALENDAR YEAR 1904

PREPARED UNDER THE DIRECTION OF F. H. NEWELL
BY
D. W. ROSS, J. T. WHISTLER, and T. A. NOBLE

PART XII.—Columbia River and Puget Sound Drainage.

WASHINGTON
GOVERNMENT PRINTING OFFICE
1905

CONTENTS.

	Page.
Letter of transmittal	9
Introduction	11
Cooperation and acknowledgments	20
Columbia River drainage basin	21
Columbia River near Pasco, Wash	24
Kootenai River near Bonners Ferry, Idaho	25
Missoula River at Missoula, Mont	28
Big Blackfoot River near Bonner, Mont	32
Bitterroot River near Grantsdale, Mont	35
Bitterroot River near Missoula, Mont	37
Clark Fork at Priest River, Idaho	40
Priest River at Priest River, Idaho	43
Spokane River at Spokane, Wash	46
Hangman Creek at Tekoa, Wash	51
Hangman Creek at Poole's ranch, near Tekoa, Wash	54
Hangman Creek (North Fork) at Tekoa, Wash	55
Little Spokane River near Spokane, Wash	57
Sinlahekin Creek near Loomis, Wash	59
Johnson Creek near Riverside, Wash	61
Salmon Creek near Malott, Wash	63
Methow River near Pateros, Wash	65
Chelan River below Lake Chelan, Wash	68
Wenache River at Cashmere, Wash	71
Crab Creek at Wilson Creek, Wash	73
Yakima River near Martin, Wash	74
Yakima River at Easton, Wash	76
Yakima River near North Yakima, Wash	79
Yakima River near Yakima, Wash	81
Yakima River at Prosser, Wash	85
Yakima River at Kiona, Wash	87
Kachess River near Easton, Wash	90
Cleslum River near Roslyn, Wash	92
Naches River near Nile, Wash	95
Naches River near North Yakima, Wash	98
Tieton River near North Yakima, Wash	103
Atanum Creek near Yakima, Wash	105
Canals in the Yakima River Valley, Washington	107
Cascade canal near Thorp, Wash	109
West Kittitas canal near Thorp, Wash	109
Town canal near Ellensburg, Wash	111
Olsen (or Mill) ditch near Ellensburg, Wash	113
Selah-Moxee canal near North Yakima, Wash	113

Columbia River drainage basin—Continued. Page.
Canals in the Yakima River Valley, Washington—Continued.
Taylor canal near North Yakima, Wash. 116
Moxee and Hubbard canals near North Yakima, Wash. 116
Fowler canal near North Yakima, Wash. 120
Granger canal near North Yakima, Wash. 122
New Reservation canal No. 2 in Yakima Indian Reservation, Wash. 123
Old Reservation canal No. 1 in Yakima Indian Reservation, Wash. 125
Government canal No. 3 near Toppenish, Wash. 127
Sunnyside canal near Yakima, Wash. 127
Gilbert canal near Toppenish, Wash. 130
Hatch canal near Toppenish, Wash. 133
Prosser Falls Irrigation Company's power canal at Prosser, Wash. 133
Ledbetter canal near Prosser, Wash. 136
Kiona canal near Kiona, Wash. 136
Kiona Water Supply Company's canal near Kiona, Wash. 138
Kennewick canal near Kennewick, Wash. 138
Grosscup's canal near Kiona, Wash. 141
Sinclair and Cobb canal near North Yakima, Wash. 141
Selah Valley canal near North Yakima, Wash. 141
Wapatox canal near North Yakima, Wash. 144
Small canals near North Yakima, Wash. 146
Gleed canal near North Yakima, Wash. 147
Yakima Valley canal near North Yakima, Wash. 149
Naches-Cowiche canal near North Yakima, Wash. 152
Broadgauge canal near North Yakima, Wash. 154
Power canal at North Yakima, Wash. 156
Shanno canal at North Yakima, Wash. 158
Union canal at North Yakima, Wash. 160
Town canal at North Yakima, Wash. 163
Northwestern Light and Water Company's proposed canal. 165
Canals taking water from Yakima, Tieton, and Naches rivers. 165
Snake River (North Fork) near Ora, Idaho. 170
Snake River near Minidoka, Idaho. 172
Fall River at Fremont, Idaho. 175
Teton River near St. Anthony, Idaho. 177
Snake River (South Fork) at Moran, Wyo. 179
Snake River (South Fork) near Lyon, Idaho. 182
Willow Creek near Prospect, Idaho. 185
Blackfoot River near Presto, Idaho. 186
Big Lost River near Mackay, Idaho. 187
Big Lost River near Chilly, Idaho. 189
Big Wood River near Gimlet, Idaho. 192
Little Wood River near Carey, Idaho. 193
Succor Creek near Homedale, Idaho. 195
Owyhee River near Owyhee, Oreg. 196
Boise River near Boise, Idaho. 199
Malheur River near Westfall, Oreg. 203
Malheur River at Vale, Oreg. 206
Malheur River at McLaughlin's bridge, near Vale, Oreg. 208
Malheur River at Halliday's bridge, near Ontario, Oreg. 209

Columbia River drainage basin—Continued. Page.
Malheur River near Ontario, Oreg. 210
Bully Creek above Vale, Oreg. 211
Bully Creek at Vale, Oreg. 213
Willow Creek near Malheur, Oreg. 215
Willow Creek near Dell, Oreg. 216
Weiser River near Weiser, Idaho. 219
Powder River near Baker City, Oreg. 221
Grande Ronde River at Hilgard, Oreg. 224
Grande Ronde River at Elgin, Oreg. 226
Grande Ronde River at Zindel, Wash. 229
Wallowa River near Joseph, Oreg. 230
Wallowa River near Wallowa, Oreg. 232
Wallowa River near Elgin, Oreg. 235
Asotin Creek 1¼ miles above Asotin, Wash. 237
Asotin Creek at Shelman's ranch, near Asotin, Wash. 239
Palouse River at Elberton, Wash. 240
Palouse River at Hooper, Wash. 243
Rock Creek near St. John, Wash. 247
Cow Creek near Keystone, Wash. 250
Cow Creek at Hooper, Wash. 251
Walla Walla River (South Fork) near Milton, Oreg. 251
Walla Walla River at Milton, Oreg. 254
Umatilla River at Gibbon, Oreg. 256
Umatilla River at Pendleton, Oreg. 258
Umatilla River at Yoakum, Oreg. 260
Umatilla River near Umatilla, Oreg. 263
McKay Creek near Pendleton, Oreg. 266
John Day River at McDonald, Oreg. 268
Deschutes River near Bend, Oreg. 269
Deschutes River (East Fork) at Odell, Oreg. 269
Miscellaneous measurements. 270
Puget Sound drainage basin. 276
Cedar River near Ravensdale, Wash. 276
Skykomish River (South Fork) near Index, Wash. 278
Snoqualmie River near Snoqualmie Falls, Wash. 281
Miscellaneous measurements. 284
Index. 285

ILLUSTRATIONS.

		Page.
PLATE I.	Map showing location of principal gaging stations in the United States	12
II.	Price current meters, with buzzers	14
FIG. 1.	Cable station, showing section of the river, car, gage, etc	13

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
HYDROGRAPHIC BRANCH,
Washington, D. C., May 17, 1905.

SIR: I transmit herewith the manuscript of Part XII of a series of twelve papers which compose the Report of Progress of Stream Measurements for the Calendar Year 1904. Parts I to VI of this report contain the results of the data collected in the territory east of Mississippi River. Parts VII to XII are devoted to the data collected in the territory west of Mississippi River.

The data for this paper were collected under the direction of T. A. Noble, D. W. Ross, and J. T. Whistler. Mr. Noble had charge of the work in Washington, and was assisted by G. H. Bliss, G. F. Harley, and W. G. Steward. Mr. Ross had charge of the work in Idaho and was assisted by Robert Stockton and J. B. Bond. Mr. Whistler had charge of the work in Oregon and was assisted by W. C. Sawyer and J. H. Lewis.

The assembling of the data and the preparation for publication were done under the direction of John C. Hoyt, who has been assisted by R. H. Bolster, Robert Follansbee, Willis E. Hall, G. F. Harley, A. H. Horton, and H. D. Padget.

I request that this manuscript be published as one of the series of water-supply and irrigation papers.

Very respectfully,

F. H. NEWELL, *Chief Engineer.*

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

PROGRESS REPORT OF STREAM MEASUREMENTS FOR THE CALENDAR YEAR 1904.

PART XII.

By D. W. Ross, J. T. Whistler, and T. A. Noble.

INTRODUCTION.

The hydrographic work of the United States Geological Survey includes the collection of facts concerning, and the study of conditions affecting, the behavior of water from the time it reaches the earth as rain or snow until it joins the oceans or great navigable rivers. These investigations became a distinct feature of the work of the Survey in the fall of 1888, when an instruction camp was established at Embudo. N. Mex. Since that date the work has been continually and gradually extended as larger funds became available. The first distinctive appropriation for gaging streams was made by the act of August 18, 1894, which contained an item of $12,500 "for gaging the streams and determining the water supply of the United States, including the investigation of underground currents and artesian wells in the arid and semiarid sections." (Digest of Appropriations for 1895, p. 270.)

Since that time a similar act has been passed each year and the appropriations have gradually increased, as shown in the following table:

Annual appropriations for hydrographic surveys.

Year ending June 30, 1895	$12,500
Year ending June 30, 1896	25,000
Year ending June 30, 1897	50,000
Year ending June 30, 1898	50,000
Year ending June 30, 1899	50,000
Year ending June 30, 1900	50,000
Year ending June 30, 1901	100,000
Year ending June 30, 1902	100,000
Year ending June 30, 1903	200,000
Year ending June 30, 1904	200,000
Year ending June 30, 1905	200,000
Year ending June 30, 1906	200,000

The chief feature of the work of the hydrographic division is the systematic study of the flow of the surface waters and the conditions affecting the same. In this connection other information that may be of use to the engineer or others in hydrographic studies, such as river profiles, duration and extent of damage by floods, water-power data, etc., is collected. Furthermore, the work has been so directed that the information collected will be of direct value in the commercial and agricultural development of the country.

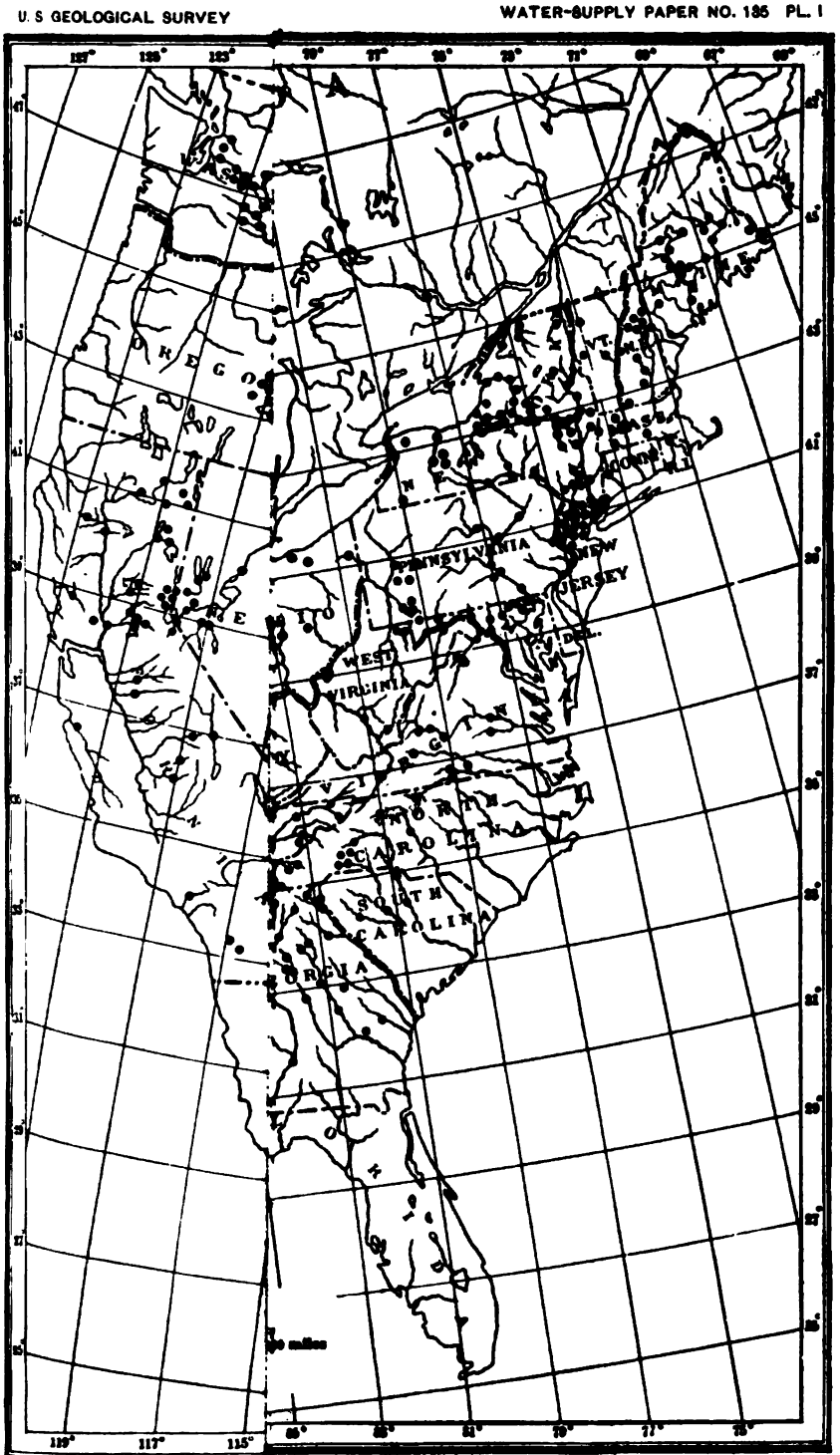
As a result of the increased appropriations since June 30, 1902, the work has been largely extended and thoroughly systemized. The various States have been grouped into districts, each of which is under the supervision of a district hydrographer who, with a corps of assistants, devotes his whole time to the study of the hydrographic resources of his district.

The methods used in the collection of these data and in their preparation for publication are given in detail in Water-Supply Paper No. 94. (Hydrographic Manual, U. S. Geol. Survey.)

The general plan of stream gaging which has been developed is to obtain eventually data in regard to the flow of all the important streams in the United States. With this in view, gaging stations are established at points where the data will be of greatest commercial value. At these stations discharge measurements are taken from time to time at typical river stages, and the daily surface fluctuation is obtained by means of gage readings. From these two factors it is possible to estimate both the total flow and its distribution through the period of observation.

The selection of the site for a gaging station and the length of time the station is maintained depend largely upon the needs of each locality. If the stream is to be used for water power, special efforts are made to obtain information concerning the low-water flow. If water is to be stored, the high waters are given special attention. In all sections certain permanent stations are maintained for general statistical purposes to show the conditions which exist through long periods. They also act as primary stations, and are used in connection with short series of measurements to determine the flow in particular portions of the drainage basin.

Gaging stations are divided into two general classes: First, current-meter stations, and second, weir stations. The former class is subdivided as to location into bridge, cable, boat, and wading stations. Fig. 1 shows a cable station with car, tag line, inclined gage, etc. In addition to the bridge, cable, or boat, the equipment of a current-meter gaging station consists in a gage for determining the daily fluctuations of the water surface, bench marks to which the zero of the gage is referred, and permanent marks on the bridge or a tagged line indicating the points of measurement. Where the current is swift



MAINED DURING 1904.

some appliance, generally a secondary cable, is necessary to hold the meter below the surface.

Gaging stations are generally located at bridges, if the channel conditions are satisfactory, as from them the meter can be easily manipulated and the cost of the equipment is comparatively small. The stations are located as far as possible at points where the channel is straight, both above and below the gaging section, and where there are no cross currents, backwater, or boils. The bed of the stream should be as clear as possible from large projections and of a permanent character. The banks should be high, and should overflow at high stages only. At stations with shifting beds more measurements are made, and special methods of computing daily discharges are employed. Great care is taken in the selection and equipment of gaging stations, in order that the data may have the required degree of accuracy.

On many of the larger rivers, where water power is developed by dams, estimates of flow are obtained by observing the head on the

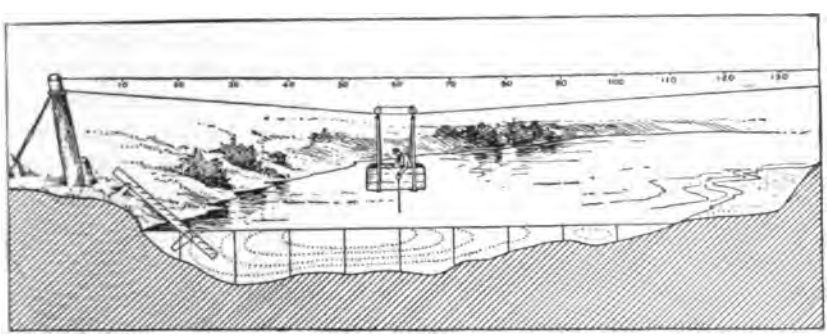


FIG. 1.—Cable station, showing section of river, car, gage, etc.

crest and using a weir formula. On the smaller streams sharp-crested weirs are in some cases erected.

The principal instrument used in stream-measurement work is the current meter, by which the velocity of the flow of water is determined. After years of experience the Survey has adopted the Price current meter for general work. This meter, as is shown on Pl. II, is made in two sizes, known as the large and small Price. The small Price has been largely developed by the officers of the Survey, using the Price acoustic meter as a basis.

A discharge measurement is the determination of the quantity of water flowing past a certain point at a given time. This quantity is the product of two factors: (1) The mean velocity, which is the function of the cross section, surface slope, wetted perimeter, and roughness of bed; (2) the area, which depends upon the permanency of the bed and the fluctuations of the surface, which govern the depth.

In making the measurement an arbitrary number of points are laid off perpendicular to the thread of the stream (see fig. 1). These points are usually at regular intervals varying from 2 to 20 feet, depending upon the size and conditions of the stream. They are known as measuring points, and at them the observed data, the velocities and soundings, are taken. The perpendiculars dropped from the measuring points divide the gaging section into strips, and for each strip or pair of strips the mean velocity, area, and discharge are determined independently; thus conditions existing in one part of the stream are not distributed to parts where they do not apply.

The methods of obtaining velocity with the current meters which are in general use may be grouped into three classes: Single point, multiple point, and integration.

The single-point method consists in holding the meter either at the depth of the thread of mean velocity or at an arbitrary depth for which the coefficient for reducing to mean velocity has been determined. Extensive experiments by vertical velocity-curves show that the thread of mean velocity lies at from 0.5 to 0.7 of the total depth. In general practice the thread of mean velocity is considered to be at 0.6 depth, and it is at this depth that the meter is held in the majority of the measurements, this being known as the six-tenths depth method. It is found by a large number of vertical velocity-curve measurements, taken on various streams and under various conditions, that the coefficient for reducing the velocity obtained at six-tenths depth to mean velocity is practically unity, ranging, in a series of 910 measurements made at 39 gaging stations, between .94 and 1.04, with a mean for the 910 observations of 1.00. In the other principal single-point method the meter is held near the surface, usually 1 foot below, or low enough to be out of the action of the wind or other disturbing influences. This is known as the subsurface method. The coefficient for reducing the velocities taken at the subsurface has been found by repeated experiments with vertical velocity-curves to be from .85 to .95, depending upon the depth of the stream and velocity and channel conditions. This method is specially adapted for flood measurements or when the velocity is so great that the meter can not be kept at 0.6 depth.

The three principal multiple-point methods in general use are: The vertical velocity curve; top and bottom; and top, bottom, and mid depth. In the vertical velocity-curve method a series of velocity determinations are taken in the vertical at regular intervals, usually from 0.5 to 1 foot apart. By plotting these velocities as abscissas and their depths as ordinates, and drawing a smooth curve through these points, the vertical velocity-curve is produced, which shows the change in velocity from the surface to the bottom of the stream. The mean velocity in the vertical is then obtained by dividing the depth

PRICE CURRENT METERS, WITH BUZZERS.

into the area bounded by this mean velocity-curve and the initial line. Owing to the length of time it takes to make these measurements, they are seldom used except for determining coefficients for purposes of comparison and for measurements under ice.

In the second multiple-point method the meter is held from 0.5 to 1 foot below the surface and about 0.5 foot above the bottom, and the mean of the velocities at these two points is taken as the mean velocity for that vertical. This method is not well adapted for general work, as the roughness of the bottom disturbs the velocity at that point. For shallow streams with comparatively smooth beds good results are obtained by this method. In the third multiple-point method the meter is held at mid depth, 0.5 foot below the surface, and 0.5 foot above the bottom, and the mean velocity is determined by dividing the sum of the top velocity, twice the mid-depth velocity, and the bottom velocity by 4.

The vertical-integration method consists in moving the meter at a slow, uniform speed from the surface to the bottom and back again to the surface. The number of revolutions and the time taken in the operation is noted, and the mean velocity is found by dividing the number of revolutions by the number of seconds taken in the run. This method has the advantage in that the velocity at each point of the vertical is measured twice. It is well adapted for measurements under ice and as a check on the point methods.

The area, which is the other factor for determining the discharge of the stream, depends upon the stage of the river, which is taken on a gage, and the general contour of the bed of the stream, which is found by sounding. The soundings are usually taken at each measuring point at the time of the discharge measurement, either by using the meter and cable or by a special sounding line or rod. For stations with permanent beds standard cross sections are usually taken during low water. These sections serve to check the soundings which are taken at the time of the measurements, and from them any change which may have taken place in the bed of the stream can be detected. They are also used for obtaining the area for use in high-water measurement computations, as accurate soundings are hard to obtain at high stages.

In computing the discharge measurements from the observed velocities and depths at the various points of measurements the measuring section is divided into elementary strips, as shown in fig. 1, and the mean velocity, area, and discharge are determined separately for either a single or double strip. The total discharge and area are the sums of those for the various strips, and the mean velocity is obtained by dividing the total discharge by the total area.

The volume of water flowing in a stream is known as run-off. In expressing it various units are used, depending upon the kind of work

for which the data are needed. Those used in this report are "second-feet," "acre-feet," "run-off per square mile," and "run-off in depth in inches," and may be defined as follows:

"Second-foot" is an abbreviation for cubic foot per second, and is the body of water flowing in a stream 1 foot wide, 1 foot deep, at a rate of 1 foot per second.

The "acre-foot" is the unit of capacity used in connection with storage for irrigation work, and is equivalent to 43,560 cubic feet. It is the quantity required to cover an acre to a depth of 1 foot. There is a convenient relation between the second-foot and the acre-foot; 1 second-foot flowing for twenty-four hours will deliver 86,400 cubic feet, which equals 1.9835 acre-feet, or approximately 2 acre-feet.

The expression "second-feet per square mile" means the number of cubic feet of water flowing each second from every square mile of drainage area on the assumption that the run-off is uniformly distributed.

"Depth in inches" means the depth of water in inches that would have covered the drainage area, uniformly distributed, if all the water could have accumulated on the surface. This quantity is used for comparing run-off with rainfall, which quantity is usually given in depth in inches.

It should be noticed that "acre-feet" and "depth in inches" represent the actual quantities of water which are produced during the periods in question, while "second-feet," on the contrary, is merely a rate of flow, per second.

The base data for computing the daily discharge of a stream are the daily gage heights, and the various discharge measurements of which there should be sufficient number to cover the range of stage. The fundamental laws upon which these computations are based are the following:

(1) The discharge will remain constant so long as the conditions at or near the gaging station remain constant;

(2) Neglecting the change of slope due to the rise and fall of the stream, the discharge will be the same whenever the stream is at a given stage; and

(3) The discharge is both a function of, and increases gradually with, the gage heights. (2 and 3 depend on 1.)

As the beds of many streams are changeable, the problem divides itself into two classes: (1) Those of streams with permanent or practically permanent beds, and (2) those of streams with changeable beds. The base data and methods of obtaining them are the same for either class, and it is only in the computation of the mean daily flow that different methods are necessary.

In determining the daily discharge of streams with permanent beds the results of the discharge measurements are plotted on cross-section

paper, with gage heights as ordinates and discharges as abscissas. Through these points a smooth curve is drawn, which shows the discharge for any gage height, and from which a rating table is prepared. Aside from plotting the discharge, the mean velocity and area determined for each discharge measurement are plotted. Through these points the curves of mean velocity and of area are drawn, and the rating curve is largely determined by taking the product of the mean velocity and the area at various stages as determined by these curves. These curves of mean velocity and area are of special value to determine the location of the rating curve for stages at which actual discharge measurements are not available and for extending the discharge curve outside the limits of the measurements. In the preparation of the rating table the discharge for each tenth or half tenth on the gage is found from the curve. The first and second differences of these discharges are then taken and adjusted according to the law that they shall either be constant or increasing, never decreasing. The discharges in the table are then changed in accordance with these adjusted differences. In making up the station-rating curve the individual discharge measurements and the conditions under which they were taken are carefully studied in order that proper weight shall be given to each measurement. Rating curves in general take the form of a parabola, and as a rule the high-water portion of the curve approaches a straight line. For stations of permanent character the results of the measurements from year to year should be within 5 per cent of the curve, with the exception of those taken during high water, when the probable error may be as high as 10 per cent.

The determination of the daily discharge of streams with changeable beds is difficult, and unless frequent discharge measurements are made the results obtained are only roughly approximate. For streams with continually shifting beds, such as Colorado River and the Rio Grande, discharge measurements are made every two or three days, and the discharges for the intervening days are obtained by interpolation, modified by the gage heights for these days. For stations with beds which shift slowly, or are only materially changed during floods, station-rating curves and tables can be prepared for the periods between changes, and satisfactory results can be obtained with two or three measurements a month, providing measurements are taken soon after the changes take place.

In determining the flow for periods when the streams are frozen, special rating curves and tables have to be prepared from measurements taken under these conditions. The methods of constructing these curves and tables are the same as for open sections. The discharge measurements, however, are either taken by integration in

verticals or by the vertical velocity-curve method, as sufficient experiments have not been made on ice-covered streams to determine the laws which govern the position of the thread of mean velocity.

The Report of Progress of Stream Measurements for the Calendar Year 1904, of which this is Part XII, is published in a series of twelve Water-Supply Papers, Nos. 124–135, inclusive, under the following subtitles:

Part 1. Atlantic coast of New England drainage.
Part 2. Hudson, Passaic, Raritan, and Delaware River drainages.
Part 3. Susquehanna, Patapsco, Potomac, James, Roanoke, Cape Fear, and Yadkin River drainages.
Part 4. Santee, Savannah, Ogeechee, Altamaha rivers, and Eastern Gulf of Mexico drainage.
Part 5. Eastern Mississippi River drainage.
Part 6. Great Lakes and St. Lawrence River drainage.
Part 7. Hudson Bay, Minnesota, Wapsipinicon, Iowa, Des Moines, and Missouri River drainages.
Part 8. Platte, Kansas, Meramec, Arkansas, and Red River drainages.
Part 9. Western Gulf of Mexico drainage.
Part 10. Colorado River and Great Basin drainage.
Part 11. The Great Basin and Pacific Ocean drainage in California.
Part 12. Columbia River and Puget Sound drainage.

The territory covered by each paper is given in the subtitle, and the larger drainages are, for convenience in arrangement, subdivided into smaller ones, under which the data are arranged, as far as practicable, geographically.

These papers contain the data that have been collected at the regular gaging stations, the results of the computations based upon the observations, and such other information that has been collected that has a direct bearing on these data, including, as far as practicable, descriptions of the drainage areas and the streams draining them.

For each regular station are given, as far as available, the following data:

1. Description of station.
2. List of discharge measurements.
3. Gage-height table.
4. Rating table.
5. Table of estimated monthly and yearly discharges and run-off.

The descriptions of stations give, as far as possible, such general facts about the locality and equipment as would enable the reader to find the station and use the same. They also give, as far as possible, a complete history of all the changes that have occurred since the establishment of the station that would be factors in using the data collected.

The discharge-measurement table gives the results of the discharge measurements made during the year. This includes the date, the

hydrographer's name, the gage height, and the discharge in second-feet.

The table of daily gage heights gives for each day the mean height of the surface of the river as found from the mean of the gage readings taken on that day. At most of the stations the gage is read in the morning and in the evening.

The rating table gives discharges in second-feet corresponding to each stage of the river as given by the gage heights.

In the table of estimated run-off the column headed "Maximum" gives the mean flow for the day when the mean gage height was the highest, and it is the flow as given in the rating table for that mean gage height. As the gage height is the mean for the day, there might have been short periods when the water was higher and the corresponding discharge larger than given in this column. Likewise in the column of "Minimum" the quantity given is the mean flow for the day when the mean gage height was lowest The column headed "Mean" gives the average flow for each second during the month. Upon this mean the computations for the three remaining columns which are defined on page 16 are based.

In the computations for the tables of this report the following general and special rules have been used:

Fundamental rules for computation.

1. The highest degree of precision consistent with the rational use of time and money is imperative.

2. All items of computation should, in general, be expressed by at least two and by not more than four significant figures.

3. Any measurement in a vertical velocity, mean velocity, or discharge curve whose per cent of error is 5 times the average per cent error of all the other measurements should be rejected.

4. In reducing the number of significant figures, or the number of decimal places, by dropping the last figure, the following rules apply:

(a) When the figure in the place to be rejected is less than 5, drop it without changing the preceding figure. Example: 1,827.4 becomes 1,827.

(b) When the figure in the place to be rejected is greater than 5, drop it and increase the preceding figure by 1. Example: 1,827.6 becomes 1,828.

(c) When the figure in the place to be rejected is 5, and it is preceded by an even figure, drop the 5. Example: 1,828.5 becomes 1,828.

(d) When the figure in the place to be rejected is 5, and it is preceded by an odd figure, drop the 5 and increase the preceding figure by 1. Example: 1,827.5 becomes 1,828.

5. In constructing and applying rating tables a maximum limit of one-half per cent error should seldom be exceeded.

Special rules for computation.

1. Rating tables are to be constructed as close as the data upon which they are based will warrant. No decimals are to be used when the discharge is over 50 second-feet.

2. Daily discharges shall be applied directly to the gage heights as they are tabulated.

3. Monthly means are to be carried out to one decimal place when the quantities are below 100 second-feet. Between 100 and 10,000 second-feet, the last figure in the monthly mean shall be a significant figure. This also applies to the yearly mean.

4. Second-feet per square mile and depth in inches for the individual months shall be carried out at least to three significant figures, except in the case of decimals, where the first significant figure is preceded by one or more "0," when the quantity shall be carried out to two significant figures. Example: 1.25; .125; .012; .0012. The yearly means for these quantities are always to be expressed in three significant figures and at least two decimal places.

The results of the stream measurements made during previous years by the United States Geological Survey can be found in the following Survey publications. A detailed index of the reports for years previous to 1904 is given in Water-Supply Paper No. 119.

1888. Tenth Annual Report, Part II.
1889. Eleventh Annual Report, Part II.
1890. Twelfth Annual Report, Part II.
1891. Thirteenth Annual Report, Part III.
1892. Fourteenth Annual Report, Part II
1893. Bulletin No. 131.
1894. Bulletin No. 131; Sixteenth Annual Report, Part II.
1895. Bulletin No. 140.
1896. Water-Supply Paper No. 11; Eighteenth Annual Report, Part IV.
1897. Water-Supply Papers Nos. 15 and 16; Nineteenth Annual Report, Part IV.
1898. Water-Supply Papers Nos. 27 and 28; Twentieth Annual Report, Part IV.
1899. Water-Supply Papers Nos. 35 to 39, inclusive; Twenty-first Annual Report, Part IV.
1900. Water-Supply Papers Nos. 47 to 52, inclusive; Twenty-second Annual Report, Part IV.
1901. East of Mississippi River, Water-Supply Papers Nos. 65 and 75.
West of Mississippi River, Water-Supply Papers Nos. 66 and 75.
1902. East of Mississippi River, Water-Supply Papers Nos. 82 and 83.
West of Mississippi River, Water-Supply Papers Nos. 84 and 85.
1903. East of Mississippi River, Water-Supply Papers Nos. 97 and 98.
West of Mississippi River, Water-Supply Papers Nos. 99 and 100.
1904. East of Mississippi River, Water-Supply Papers Nos. 124 to 129, inclusive.
West of Mississippi River, Water-Supply Papers Nos. 130 to 135, inclusive.

A limited number of these are for free distribution, and as long as the supply lasts they may be obtained by application to the Director United States Geological Survey or to members of Congress. Other copies are filed with the Superintendent of Public Documents, Washington, D. C., from whom they may be had at prices little above cost. Copies of Government publications are, as a rule, furnished to the public libraries in our large cities, where they may be consulted by those interested.

COOPERATION AND ACKNOWLEDGMENTS.

Most of the measurements presented in this paper have been obtained through local hydrographers. Acknowledgment is extended to other persons and corporations who have assisted local hydrographers or have cooperated in any way, either by furnishing records of the height of water or by assisting in transportation.

The following list, arranged alphabetically by States, gives the names of the resident hydrographers and others who have assisted in furnishing and preparing the data contained in this report:

Idaho.—District engineer, D. W. Ross [a], assisted by Fred Stockton, William G. Davies, and J. B. Bond. Acknowledgments and thanks are due the Oregon Short Line Railroad Company for transportation furnished the district hydrographer and his assistants.

Montana.—District engineer, C. C. Babb [b], assisted by A. E. Place, L. R. Stockman, and Robert Follansbee, assistant engineers, and W. B. Freeman, engineering aid.

Oregon.—District engineer, J. T. Whistler [c], assisted by J. H. Lewis during the first quarter, and by Wilbur C. Sawyer, E. N. Smith, and Ivan Landes the remainder of the year. Acknowledgment and thanks are due the Oregon Railroad and Navigation Company, Southern Pacific Railway Company, Oregon Short Line Railroad Company, Sumpter Valley Railway, and the Columbia Southern Railway for transportation; to the Pacific Live Stock Company, through Mr. Gilchrist, superintendent, for gratuitous gage readings, to W. C. McDonald for the use of his ferry cable on John Day River as a gaging station, and to Mr. J. H. Cunningham, civil and hydraulic engineer, Portland, Oreg., for several miscellaneous current meter measurements.

Washington.—District engineer, T. A. Noble [d], assisted by George H. Bliss, W. G. Steward, and George F. Harley. Acknowledgments and thanks are due to the many owners and managers of irrigation canals in Yakima River Valley for assistance and information furnished in the prosecution of the work in that locality. Acknowledgments are also due to the Washington Irrigation Company, through Walter N. Granger, manager; Northern Pacific Irrigation Company, through O. L. Hanson, superintendent; Washington Water-Power Company, Northern Pacific Railway, Great Northern Railway, and Oregon Railroad and Navigation Company, for assistance and information.

Wyoming.—District hydrographer, M. C. Hinderlider [e], and resident hydrographer, A. J. Parshall. Acknowledgments are due for annual passes over all their lines in Wyoming to the Union Pacific Chicago, Burlington and Quincy; Colorado and Southern; Colorado and Wyoming; and Fremont, Elkhorn and Missouri River Valley Railroad Companies.

COLUMBIA RIVER DRAINAGE BASIN.

Next to the Colorado, Columbia River drains the largest area of all rivers in the arid region. Its drainage basin includes parts of Washington, Oregon, Idaho, Montana, and a large area in Canada. No extensive observations of its flow have been made, but the data obtained indicate that the discharge of Columbia River is much greater than that of the Colorado. The Columbia and its numerous tributaries are of great importance, offering good sites for water-power development and an abundance of water for irrigation, while the main river is navigable for a considerable distance.

A great part of the water of Columbia River and its tributaries flows to waste, not being utilized. This is due to the fact that the river has cut so deeply into the lava-covered plains that water can not be diverted except at points near the mountains, where the streams

[a] Office of district engineer, Boise, Idaho.
[b] Office of district engineer, Browning, Mont.
[c] Office of district engineer, Pendleton, Oreg.
[d] Office of district engineer, North Yakima, Wash.
[e] Office of district hydrographer, Chamber of Commerce Building, Denver, Colo

The following rivers in the Columbia drainage basin are also worthy of mention: The Walla Walla, the drainage of which is one of the best irrigated and most productive localities in either Washington or Oregon; Owyhee River, which rises in northwestern Nevada and flows southwest through Idaho; Malheur River, rising in the mountains of east-central Oregon and emptying into Snake River west of Boise; the Grande Ronde, which drains the northern slope of the Blue Mountains and empties into Snake River in southeastern Washington.

The following pages give the results of data collected in Columbia River drainage basin during 1904:

COLUMBIA RIVER NEAR PASCO, WASH.

This station was established October 15, 1904, by C. B. Cox. It is located 1.2 miles from Pasco, Wash., at the bridge of the Northern Pacific Railway Company. A staff gage, in two sections, graduated to feet and tenths, is bolted vertically to the third pier from the east end of the bridge. The lower section is graduated from zero to 10 feet. The upper section is graduated from zero to 20 feet, with its zero at the 10-foot mark of the lower section. Gage readings have been reduced to the zero of the lower section. The gage is read once each day by W. B. Sloan. Discharge measurements are made by means of a boat held from the bridge to which the gage is attached by means of a 400-foot, one-fourth inch rope cable. The meter is lowered 2 feet above the bow of the boat over a roller on a projecting plank and controlled by a windlass. The initial point for soundings is 400 feet below the railway bridge, opposite the center of the east pier. The channel is curved for about 800 feet above and straight for about one-fourth mile below the station. The water above the station is smooth. It becomes swift and rough on the west side of the channel 600 feet below the station. Both banks overflow during high water. The bed of the stream is composed of bowlders and is fairly permanent. There is one channel at high, and two at very low stages. The piers of the bridge, a bar 600 feet below the station, and the movement of the boat affect the measurements. A United States Geological Survey standard aluminum bench-mark tablet marked "350" is placed on the south side of the first pier from the east end of the bridge. Its elevation is 349.78 feet above sea level and 42.03 feet above the gage datum. A United States Coast and Geodetic Survey brass bench-mark tablet on the same pier has an elevation of 44.51 feet above the datum of the gage.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurement of Columbia River near Pasco, Wash., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
October 8	C. B. Cox	22,660	2.82	9.90	64,000

Mean daily gage height, in feet, of Columbia River near Pasco, Wash., for 1904.

Day.	Nov.	Dec.	Day.	Nov.	Dec.	Day.	Nov.	Dec.
1	8.6	8.7	12	8.4	8.1	23	8.4	8.1
2	8.6	8.6	13	8.3	8.2	24	8.4	8.1
3	8.6	8.5	14	8.3	8.1	25	8.5	8.0
4	8.5	8.5	15	8.3	8.1	26	8.5	7.9
5	8.5	8.4	16	8.3	8.0	27	8.5	7.8
6	8.5	8.4	17	8.3	8.0	28	8.6	7.7
7	8.5	8.3	18	8.3	8.1	29	8.6	7.7
8	8.4	8.2	19	8.3	8.1	30	8.7	7.7
9	8.4	8.1	20	8.3	8.1	31	.....	7.6
10	8.4	8.1	21	8.3	8.1			
11	8.4	8.1	22	8.4	8.1			

KOOTENAI RIVER NEAR BONNERS FERRY, IDAHO.

This station was established May 10, 1904, by W. W. Schlecht. It is located at the Great Northern Railway Company's bridge, three-fourths mile below Bonners Ferry, Idaho, 40 miles above Kootenai Lake, and 5 miles below the mouth of Moyie River. A standard chain gage is securely nailed to floor beams near the first bridge pier from the left bank. The length of the chain from the outer edge of the ring to the lower end of the weight is 43.10 feet. The datum of the gage is 1,727.53 feet above sea level, as determined from the datum of the Great Northern Railway at Bonners Ferry. The gage is read once each day by L. Christenson. Discharge measurements are made from the upstream side of the railroad bridge to which the gage is attached. This consists of three stationary and one draw span and a trestle approach at the left bank. The upstream guard timber along the bridge is marked every 5 feet and numbered every 10 feet; along the trestle the marks and numbers are 25 feet apart. A stay wire, 1,000 feet long, is stretched across the river above the bridge at the time of making each measurement. The stream is considered navigable, and the wire can not be left in position. It is stored with the observer. The initial point for soundings is the mean outer face of the northernmost pier, marked with a 10-penny nail and has zero painted in white on the upstream guard timber. The channel is straight for about 1,000 feet above and 350 feet below the station. About 500 feet below the station there is a sharp curve to the right. The current is sluggish. The right bank is high, wooded, and not

liable to overflow. The left bank is low, wooded, and liable to overflow to the railroad embankment which is about 1,200 feet from the bank proper. The bed of the stream is composed of sand, free from vegetation, and may shift during high water. There are five channels beneath the bridge, and during high water another channel under the trestle at sounding station No. 1750.

Bench mark No. 1 is a point on the sill of the bridge near the right bank at sounding station −52, marked "1770" (datum of the Great Northern Railway), established by a United States and Canadian Boundary Survey party. Its elevation is 42.47 feet above the datum of the gage. Bench mark No. 2 is the top of the head of a 20-penny nail driven horizontally into a signpost about 200 feet northwest of bench mark No. 1, and marked "1771.2." Its elevation is 43.637 feet above the datum of the gage. Bench mark No. 3 is an 8-penny nail driven into the diagonal brace of trestle bent below sounding station 614.3, marked "1761.4." The nail is 10.49 feet below the top of ties on the trestle. Its elevation is 33.87 feet above the datum of the gage. Bench mark No. 4 is on the cap of trestle bent, upstream side, at station 1,850 feet from the initial point for soundings. It was set by a United States and Canadian Boundary Survey party, and marked "1761." Its elevation is 33.74 feet above the datum of the gage.

On account of backwater from Lake Kootenai influencing the gage heights at the Bonners Ferry gage, a gage was set May 18, 1904, on the left bank of the river, about three-fourths mile above James Fitzpatrick's ranch, and 1 mile below the mouth of Moyie River, a large tributary from the north. This gage is about 1 mile above Crossport siding, and 5 miles above Bonners Ferry. The gage is set in two vertical sections connected by levels. The middle section is fastened to a small balm of Gilead tree, and gives the stage of the river between gage heights 20 and 30 feet. The upper section, which is fastened to a large pine stump, gives the stage of the river between gage heights 30 and 38 feet. The gage is read once each day by James Fitzpatrick. The bench mark is the top of a 20-penny nail driven into a telegraph pole near the gage. Its elevation is 37.92 feet above the datum of the gage. River heights from this gage are to be used in making estimates of flow and constructing rating table from the discharge measurements made at Bonners Ferry. At extreme high stages of the lake some backwater will probably influence the gage height, but by going farther up stream the fluctuations due to Moyie River would be omitted, and it is important to include the discharge of the latter.

In order to determine the slope of the river a gage was set May 19, 1904, at Porthill, Idaho, about 300 feet south of the United States-Canada boundary line. A staff gage is fastened vertically to a large cottonwood tree on the right bank. The gage was read once each day by Claude M. Danielson until July 25, 1904, when the gage was

discontinued. The bench mark was two 20-penny nails driven into a tree a few feet north of the depot at Porthill. Its elevation is 35.00 feet above the zero of the gage. The zero of the gage is 1,716.54 feet above sea level, as determined by a United States and Canadian Boundary Survey party from the datum of the Great Northern Railway at Bonners Ferry.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Kootenai River near Bonners Ferry, Idaho, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 13	W. W. Schlecht	497	13,880	2.09	17.29	28,950
June 23	C. M. Hurlburt	505	17,020	2.89	[a]24.00	48,580
September 15	O. Laurguard	447	7,960	1.02	[b]5.10	8,140

[a] Gage at Crossport 23.85. [b] Gage at Crossport 17.60.

Mean daily gage height, in feet, of Kootenai River near Bonners Ferry, Idaho, for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	22.90	20.80	12.10	6.30	3.30
2	.....	23.00	21.30	11.70	6.30	3.20
3	.....	22.90	21.60	11.30	6.30	3.20
4	.....	22.85	21.80	11.10	6.20	3.20
5	.....	22.80	21.75	10.90	6.10	3.20
6	.....	23.65	21.60	10.70	6.00	3.10
7	.....	24.65	21.50	10.40	5.90	3.10
8	.....	25.30	21.40	10.30	5.80	3.10
9	.....	25.20	21.30	10.20	5.70	3.00
10	17.80	24.90	21.10	10.10	5.70	3.00
11	17.60	24.20	20.70	9.90	5.70	2.90
12	17.40	23.60	20.30	9.70	5.60	2.90
13	17.25	22.80	20.00	9.50	5.50	2.80
14	17.33	22.20	19.60	9.20	5.30	2.80
15	17.80	21.90	19.10	9.00	5.10	2.70
16	17.15	22.20	18.50	8.70	5.00	.....
17	18.40	23.05	17.90	8.50	4.90	.....
18	19.10	23.80	17.30	8.40	4.80	.....
19	20.15	24.40	16.70	8.30	4.60	.....
20	21.25	24.80	16.10	8.20	4.40	.....
21	22.50	24.80	15.40	8.00	4.30	.....
22	24.25	24.40	14.70	7.80	4.20	.....
23	25.40	24.00	14.20	7.60	4.10	.....
24	25.85	23.60	14.00	7.40	4.00	.....
25	25.45	22.80	14.00	7.10	3.90	.....
26	24.50	21.80	13.90	6.90	3.80	.....
27	23.50	21.00	13.30	6.70	3.60	.....
28	23.00	20.50	12.80	6.50	3.50	.....
29	22.80	20.50	12.50	6.40	3.50	.....
30	22.80	20.50	12.50	6.30	3.40	.....
31	22.90	.....	12.50	6.30	.....	.....

Gage readings influenced by backwater.

Mean daily gage height, in feet, of Kootenai River at Crossport, Idaho, for 1904.

Day.	May.	June	July.	Aug.	Sept.	Oct.
1	.....	23.90	23.00	19.30	18.00	16.95
2	.....	23.85	23.60	19.50	18.10	16.92
3	.....	23.80	23.50	19.40	18.00	16.80
4	.....	23.75	.....	19.40	18.00	16.80
5	.....	24.40	23.30	19.50	18.00	16.80
6	.....	25.00	23.10	19.30	17.95	16.90
7	.....	25.70	23.00	19.20	17.95	16.95
8	.....	26.00	23.00	19.20	17.95	17.00
9	.....	25.00	22.80	19.30	17.95	16.90
10	.....	24.40	22.60	19.20	17.90	16.90
11	.....	23.80	22.40	19.10	17.80	16.80
12	.....	23.30	22.10	19.05	17.70	16.75
13	.....	22.90	22.00	19.00	17.70	.....
14	.....	22.80	21.90	18.90	17.65	.....
15	.....	23.00	21.60	18.70	17.60	.....
16	.....	23.60	21.20	18.70	17.50	.....
17	.....	24.00	21.10	18.70	17.50	.....
18	23.25	24.20	20.90	18.65	17.50	.....
19	23.85	25.00	20.70	18.60	17.50	.....
20	24.50	24.80	20.50	18.60	17.40	.....
21	25.30	24.30	20.10	18.50	17.30	.....
22	26.50	24.10	20.05	18.40	17.20	.....
23	27.20	23.85	20.00	18.30	17.15	.....
24	26.80	23.30	20.30	18.20	17.10	.....
25	25.50	22.60	20.20	18.20	17.05	.....
26	24.40	22.20	20.00	18.12	17.03	.....
27	23.60	22.00	19.80	18.10	17.00	.....
28	23.55	22.20	19.75	18.50	17.00	.....
29	23.70	22.40	19.80	18.50	17.00	.....
30	23.80	22.60	19.90	18.00	16.95	.....
31	23.90	.....	19.90	18.00	.....	.....

Mean daily gage height, in feet, of Kootenai River near Porthill, Idaho, for 1904.

Day.	May.	June.	July.	Day.	May.	June.	July.	Day.	May.	June.	July.
1	.....	27.6	26.7	12	.....	28.6	26.5	22	26.6	29.0	23.0
2	.....	27.7	27.0	13	.....	28.3	26.2	23	27.4	28.8	22.7
3	.....	27.6	27.1	14	.....	28.9	26.1	24	27.8	28.7	22.5
4	.....	27.7	27.1	15	.....	28.8	26.0	25	28.1	28.4	[a] 22.3
5	.....	27.8	27.1	16	.....	28.8	25.5	26	28.0	27.9	.....
6	.....	28.1	27.3	17	.....	28.0	25.3	27	27.8	27.5	.....
7	.....	28.6	27.2	18	.....	28.4	24.8	28	27.6	27.1	.....
8	.....	28.8	27.1	19	24.5	28.7	24.6	29	27.5	26.9	.....
9	.....	29.1	27.0	20	25.1	28.9	24.0	30	27.5	26.8	.....
10	.....	29.0	26.9	21	25.5	29.1	23.7	31	27.6	.....	.....
11	.....	28.9	26.7								

[a] Gage discontinued July 25. Gage used only to get the slope of the river.

MISSOULA RIVER AT MISSOULA, MONT.

The original station was established July 10, 1898, by C. C. Babb, and was located at Higgins Avenue Bridge, in Missoula. As the river at this point flows in two channels, originally two gage rods were

attached to the bridge piers, one at each channel, but as fluctuations were found to occur, this location was abandoned and a new one found May 27, 1899, some distance downstream at the bridge of the Bitterroot Valley Division of the Northern Pacific Railway. The river here is practically in one channel, except in times of flood, when some water passes through a slough 600 feet south of the bridge.

The measurements are made from the downstream side of the bridge, the initial point for soundings being over the northeast abutment opposite the center of the first angle block of the truss.

The riprapping around the crib piers of the bridge and remains of old cribs and piling in the channel under the bridge cause eddies which decrease the accuracy of measurements. At flood heights there is a visible difference in the elevation of the water surface above and below the station.

The gage is located on the right bank of the river some 400 feet above the station. It is of the standard chain type, and is attached to a horizontal timber bolted to a cottonwood tree. Timbers above and below and guy wires brace it securely. The length of chain from marker to bottom of weight is 21.89 feet. The elevation of the gage datum is 3,162.18 feet above sea level. The gage is read twice each day by Thomas E. Westby. The bench mark consists of a United States Geological Survey iron post on the north side of Front street, about 200 feet west of McCormick street, and has an elevation of 3,194.64 feet above sea level. The height of the river was read at the three rods during 1899, but all subsequent readings have been made from the new gage above.

The observations at this station during 1904 have been made under the direction of C. C. Babb, district engineer.

Discharge measurements of Missoula River at Missoula, Mont., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec. feet.*
April 28	A. E. Place	365	1,953	6.32	7.48	12,357
May 20	W. B. Freeman	329	1,833	6.25	7.25	11,457
June 22	do	297	1,441	4.54	5.97	6,544
July 10	do	190	952	3.23	4.59	3,071
July 21	do	175	912	2.58	4.04	2,353
August 25	W. B. Freeman and Robert Follansbee.	213	731	1.62	3.04	1.182
November 3	L. R. Stockman		775	1.66	3.12	1,290

Mean daily gage height, in feet, of Missoula River at Missoula, Mont., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)	.....	3.20	3.55	7.35	7.35	5.05	3.70	3.32	3.00	3.15	3.15
2	.....	.....	3.15	3.62	7.20	7.48	5.08	3.70	3.20	2.92	3.10	3.15
3	.....	.....	3.18	3.72	7.22	7.38	5.05	3.65	3.15	2.80	3.15	3.10
4	.....	.....	3.15	3.80	7.25	7.20	5.00	3.60	3.12	2.75	3.15	3.10
5	.....	b 3.25	3.15	3.88	7.20	7.00	4.98	3.58	3.10	2.75	3.10	3.05
6	.....	.....	3.15	4.02	7.08	7.00	4.85	3.50	3.05	2.82	3.10	3.03
7	.....	.....	3.18	4.22	7.00	7.02	4.78	3.42	3.10	3.00	3.15	3.00
8	.....	.....	3.20	4.38	6.88	7.00	4.72	3.40	3.10	3.10	3.13	2.85
9	.....	.....	3.22	4.50	6.62	6.92	4.58	3.40	3.08	3.15	3.10	2.93
10	.....	.....	3.20	4.68	6.68	6.90	4.55	3.40	3.00	3.15	3.10	3.12
11	.....	.....	3.18	5.35	6.60	6.80	4.55	3.35	3.00	3.10	3.08	3.08
12	.....	.....	3.10	6.32	6.63	6.48	4.45	3.32	2.98	3.10	3.05	3.10
13	.....	.....	3.12	6.52	6.73	6.38	4.40	3.30	2.97	3.10	3.05	3.12
14	.....	.....	3.15	6.45	6.75	6.28	4.38	3.25	2.98	3.10	3.05	3.00
15	.....	.....	3.18	6.35	6.85	6.20	4.35	3.22	3.00	3.05	3.05	3.05
16	b 3.20	.....	3.25	6.18	6.90	6.30	4.35	3.22	2.95	3.05	3.10	3.10
17	.....	.....	3.32	.....	6.92	6.48	4.32	3.20	2.95	3.10	3.12	3.05
18	.....	.....	3.40	6.28	6.98	6.50	4.35	3.18	2.95	3.15	3.15	3.05
19	.....	.....	3.45	6.45	7.10	6.40	4.28	3.15	2.95	3.35	3.15	3.05
20	.....	.....	3.42	6.58	7.38	6.30	4.20	3.15	2.95	3.28	3.13	3.10
21	.....	.....	3.45	6.70	7.45	6.18	4.08	3.15	2.95	3.18	3.10	3.05
22	.....	3.15	3.40	6.78	7.78	6.00	4.00	3.15	3.00	3.08	3.05	3.05
23	.....	3.18	3.40	6.70	8.60	5.92	3.95	3.15	3.02	3.10	3.05	3.00
24	.....	3.20	3.35	6.60	8.35	5.75	3.95	3.10	3.00	3.10	3.05	b 2.95
25	.....	3.20	(a)	6.50	8.25	5.60	3.90	3.08	2.95	3.12	3.05	(c)
26	.....	3.20	b 2.95	6.60	7.88	5.42	3.88	3.05	2.95	3.15	3.05	.....
27	.....	3.15	.....	6.85	7.50	5.30	3.80	3.02	2.95	3.15	3.05	.....
28	.....	3.15	.....	7.18	7.20	5.22	3.80	3.05	2.92	3.15	3.10	.....
29	.....	3.20	.....	7.42	7.20	5.15	3.80	3.10	2.95	3.15	3.12	.....
30	.....	.....	3.35	7.38	7.22	5.08	3.75	3.32	3.00	3.15	3.15	.....
31	.....	.....	3.48	.....	7.20	.....	3.75	3.40	.....	3.15	.....	b 3.40

a River frozen January 1 to February 22 and also March 25 to 30.
b Readings to top of ice.
c River frozen December 24 to 31.

Rating table for Missoula River at Missoula, Mont., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.80	960	4.00	2,290	5.20	4,140	6.60	8,950
2.90	1,060	4.10	2,420	5.30	4,410	6.80	9,720
3.00	1,160	4.20	2,550	5.40	4,700	7.00	10,490
3.10	1,265	4.30	2,680	5.50	5,000	7.20	11,260
3.20	1,375	4.40	2,810	5.60	5,300	7.40	12,030
3.30	1,485	4.50	2,950	5.70	5,600	7.60	12,800
3.40	1,595	4.60	3,095	5.80	5,910	7.80	13,570
3.50	1,705	4.70	3,245	5.90	6,260	8.00	14,340
3.60	1,815	4.80	3,395	6.00	6,640	8.20	15,110
3.70	1,930	4.90	3,550	6.20	7,410	8.40	15,880
3.80	2,050	5.00	3,720	6.40	8,180	8.60	16,650
3.90	2,170	5.10	3,910				

The above table is applicable only for open-channel conditions. It is based upon 7 discharge measurements made during 1904. It is well defined between gage heights 4.00 feet and 7.50 feet. The table has been extended beyond these limits. Above gage height 6.00 feet the rating curve is a tangent, the difference being 385 per tenth.

Estimated monthly discharge of Missoula River at Missoula, Mont., for 1904.

[Drainage area, 5,960 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	.....	.....	[a] 1,300	79,934	0.218	0.251
February	.....	.....	[a] 1,300	74,777	.218	.235
March [b]	1,705	1,265	1,443	88,726	.242	.279
April	12,030	1,760	6,701	398,737	1.124	1.254
May	16,650	8,950	11,365	698,807	1.907	2.199
June	12,420	3,910	8,161	485,613	1.369	1.527
July	3,910	1,990	2,790	171,550	.468	.540
August	1,930	1,160	1,478	90,879	.248	.286
September	1,485	1,060	1,181	70,274	.198	.221
October	1,540	915	1,241	76,306	.208	.240
November	1,320	1,210	1,263	75,154	.212	.236
December	1,320	1,010	1,204	74,031	.202	.233
The year	.....	.....	3,286	2,384,788	.551	7.501

[a] Estimated.
[b] March 1 to 24 and 30 to 31, inclusive. Mean for 26 days taken as mean for month.

BIG BLACKFOOT RIVER NEAR BONNER, MONT.

This station was established for general information purposes in July, 1898, by C. C. Babb. It is situated a short distance above the junction of the Big Blackfoot with Hellgate River, at the county highway bridge one-half mile west of Bonner and 6 miles east of Missoula. The power dam of the Big Blackfoot Milling Company, about 1,000 yards above the station, interferes with the natural flow of the water, the opening and closing of the gates causing abrupt changes in the gage heights. The channel at the station is straight. Both banks are high and rocky. They are clothed with a vegetation of bushes and single trees. Neither bank is subject to inundation. The bed of the river is rocky and covered with cobbles and bowlders. It is not liable to change. The depth of water varies from 4 to 10 feet. The current is very swift and can seldom be gaged without guying the meter. The discharge measurements are made from the bridge, the distances being marked on the downstream hand rail. The initial point is a notch marked zero at the left end of the downstream hand rail. The gage is attached to the downstream guard rail. It is of the standard chain type and reads to feet and tenths. The marker is a brass-wire index near the handle. The distance from the bottom of the weight to the marker is 20.90 feet. The gage is read twice each day by Charles Anderson.

Bench mark No. 1 is a temporary bench mark of the topographic division of the United States Geological Survey, consisting of a cross cut in the northeast corner of the top of the northeast abutment of the Northern Pacific Railway bridge near Bonner. It has an elevation of 3,290.30 feet above sea level. Bench mark No. 2 is a standard United States Geological Survey iron post located in front of John McCormick's house, at the highway bridge. Its elevation is 3,246.04 feet above sea level. The elevation of the axle of an old gage pulley on the upstream side of the bridge, which serves as a temporary bench mark, is 3,251.68 feet above sea level.

The zero of the gage is 3,230.70 feet above sea level. All elevations refer to Missoula datum—25.34 feet above gage datum.

The observations at this station during 1904 have been made under the direction of C. C. Babb, district engineer.

Discharge measurements of Big Blackfoot River near Bonner, Mont., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Second feet.*
April 30	A. E. Place	134	1,031	6.48	5.10	6,755
May 19	W. B. Freeman	133	949	6.10	4.45	5,793
May 28	W. B. Freeman and E. C. Murphy.	134	950	5.72	4.48	5,431
June 20	W. B. Freeman	133	853	4.77	3.66	4,069
July 9	do	125	652	2.92	2.10	1,901
July 21	do	125	581	2.32	1.59	1,349
August 25	W. B. Freeman and Robert Follansbee.	122	465	1.31	.86	611
November 3	L. R. Stockman	120	465	1.11	.34	516

Mean daily gage height, in feet, of Big Blackfoot River near Bonner, Mont., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.65	0.50	0.40	0.70	5.07	4.51	2.40	1.29	0.83	0.57	0.36	0.31
2	.65	.50	.45	.85	4.97	4.86	2.55	1.29	.83	1.47	.36	.36
3	.70	.45	.60	.85	4.92	4.61	2.55	1.24	.83	.87	.36	.31
4	.75	.45	.55	.95	4.82	4.41	2.55	1.19	.73	.67	.41	.21
5	.75	.60	.55	1.10	4.77	4.36	2.40	1.14	.73	.45	.41	.56
6	.85	.55	.60	1.40	4.67	4.36	2.35	1.09	.73	.22	.36	.56
7	.80	.55	.65	1.65	4.62	4.41	2.25	1.09	.73	.32	.41	.31
8	.70	.50	.75	1.70	4.37	4.21	2.10	1.09	.73	.37	.46	.31
9	.60	.40	1.15	1.90	4.22	4.16	2.05	1.09	.68	.87	.46	.41
10	.60	.55	.90	2.40	4.07	4.21	2.05	1.09	.68	.47	.36	.36
11	.60	.50	.80	3.65	4.22	4.16	2.00	1.09	.....	.47	.21	.26
12	.55	.55	.70	3.65	4.17	3.86	1.95	.99	.63	.47	.31	.26
13	.60	.55	.55	3.70	3.82	3.76	1.85	.99	.63	.47	.31	.31
14	.60	.50	.55	3.85	3.97	3.51	1.85	.99	.63	.47	.31	.26
15	.60	.55	.70	4.05	4.02	3.51	1.75	.99	.58	.37	.41	.31
16	.65	.55	.65	3.80	4.12	3.58	1.72	.96	.60	39	.31	.21
17	.65	.55	.60	3.60	4.24	3.93	1.72	.96	.60	.39	41	.21
18	.65	.45	.60	3.55	4.39	3.83	1.72	.96	.60	.34	.41	.16
19	.55	.40	.60	3.85	4.59	3.83	1.72	.86	.65	.39	.41	.21
20	.65	.40	.65	4.05	4.64	3.63	1.72	.86	.60	.39	3.11	.26
21	.60	.50	.65	4.45	4.84	3.48	1.62	.86	.60	.24	.36	.26
22	.70	.55	.65	4.45	5.39	3.43	1.52	.86	.60	.54	.46	.21
23	.70	.55	.60	4.35	5.59	3.33	1.52	.86	.60	.54	.41	.21
24	.60	.45	.60	4.20	5.79	3.08	1.52	.86	.65	.39	.31	.21
25	.60	.40	.50	4.10	5.54	2.93	1.52	.86	.45	.44	.41	.16
26	.55	.45	.65	4.35	5.19	2.83	1.47	.81	.55	.44	.46	.16
27	.70	.50	.60	4.65	4.69	2.73	1.42	.76	60	.44	.36	(a)
28	.60	.40	.65	4.90	4.54	2.63	1.42	.76	.60	.44	.36	.....
29	.60	.45	.65	5.25	4.49	2.48	1.42	.76	.80	.44	.36	.....
30	.60	.....	.70	5.15	4.54	2.48	1.42	.76	.65	.44	.36	.....
31	.55	.....	.70	.....	4.64	.....	1.32	.81	.....	.44	.....	.....

a Ice, river frozen at gage.

NOTE.—Variations in gage heights due to waste gates of dam above gage.

Rating table for Big Blackfoot River near Bonner, Mont., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.20	440	1.70	1,470	3.20	3,290	4.70	6,180
0.30	480	1.80	1,560	3.30	3,440	4.80	6,420
0.40	525	1.90	1,660	3.40	3,590	4.90	6,660
0.50	575	2.00	1,770	3.50	3,740	5.00	6,900
0.60	635	2.10	1,880	3.60	3,900	5.20	7,380
0.70	705	2.20	1,990	3.70	4,070	5.40	7,860
0.80	775	2.30	2,100	3.80	4,250	5.60	8,340
0.90	845	2.40	2,210	3.90	4,430	5.80	8,820
1.00	915	2.50	2,330	4.00	4,620	6.00	9,300
1.10	985	2.60	2,460	4.10	4,820	6.20	9,780
1.20	1,060	2.70	2,590	4.20	5,030	6.40	10,260
1.30	1,140	2.80	2,730	4.30	5,250	6.60	10,740
1.40	1,220	2.90	2,870	4.40	5,480	6.80	11,220
1.50	1,300	3.00	3,010	4.50	5,710	7.00	11,700
1.60	1,380	3.10	3,150	4.60	5,940		

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1899, 1900, 1903, 1904. It is well defined between gage heights 1.00 foot and 5.00 feet. The table has been extended beyond these limits. Above gage height 5 feet the rating curve is a tangent, the difference being 240 per tenth.

Estimated monthly discharge of Big Blackfoot River near Bonner, Mont., for 1904.

[Drainage area, 2,465 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	810	605	666	40,951	0.270	0.311
February	635	525	574	33,017	.233	.251
March	1,020	525	668	41,074	.271	.312
April	7,500	705	3,785	225,223	1.535	1.713
May	8,820	4,250	6,066	372,984	2.461	2.837
June	6,540	2,330	4,217	250,929	1.711	1.909
July	2,395	1,140	1,638	100,717	.664	.766
August	1,140	740	898	55,216	.364	.420
September	810	550	684	40,701	.277	.309
October	1,260	440	581	35,724	.236	.272
November	550	440	509	30,288	.206	.230
December	610	420	472	29,022	.191	.220
The year	8,820	420	1,730	1,255,846	.702	9.550

BITTERROOT RIVER NEAR GRANTSDALE, MONT.

This station was established April 25, 1902, by H. B. Waters. It is located on the highway bridge 2 miles southwest of Grantsdale and 5 miles southwest of Hamilton, Mont. The gage was originally of the wire type and fastened to the downstream truss of the bridge. It was replaced May 2 by a standard chain gage. The gage is read daily by T. J. Holt, who lives about a quarter of a mile distant.

Two large ditches—the New Hedge and the Republican—are taken out of the river some distance above the station. They irrigate extensive farm lands and orchards in the vicinity of Hamilton.

The length of the chain from the end of the weight to the marker is 23.35 feet. Discharge measurements are made from the highway bridge on the downstream side by the aid of a stay wire. The initial point for sounding is a notch on the hand rail over the northeast bridge pier. The channel is straight both above and below the station.

The stream has a moderate velocity. The right bank has a gentle slope for about 100 feet, when it terminates in a high bank which is not liable to overflow. The left bank is high and is formed above the bridge by a railroad fill. The bed of the stream is composed of gravel and bowlders.

Bench mark No. 1 is a wire nail driven in the northeast side of a large pine stump and marked "B. M. 24.40." The stump is across the road from the west end of the bridge. The elevation above the gage datum is 24.40 feet. Bench mark No. 2 is the northwest bolt in the northwest abutment plate of the bridge. It is marked "B. M. 19.36." Its elevation above the gage datum is 19.36 feet.

The observations at this station during 1904 have been made under the direction of C. C. Babb, district engineer.

Discharge measurements of Bitterroot River near Grantsdale, Mont., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 3	A. E. Place	192	805	5.53	4.60	4,453
May 22	W. B. Freeman	205	1,215	7.69	6.44	9,340
June 21	do	193	891	5.49	4.77	4,894
July 8	do	188	680	3.80	3.66	2,584
July 22	do	180	486	2.55	2.75	1,241
August 26	W. B. Freeman and Robert Follansbee.	159	225	.37	1.37	84
November 4	L. R. Stockman		307	.76	1.70	235

Mean daily gage height, in feet, of Bitterroot River near Grantsdale, Mont., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.00	1.70	1.80	2.10	4.40	5.50	3.95	2.25	1.45	1.20	1.60	1.60
2	2.00	1.70	1.80	2.10	4.50	5.40	3.95	2.15	1.45	1.20	1.60	1.60
3	2.00	1.70	1.80	2.10	4.60	5.30	4.05	2.15	1.35	1.20	1.60	1.60
4	1.90	1.80	1.80	2.20	4.50	5.20	4.05	2.05	1.35	1.20	1.60	1.60
5	1.90	1.80	1.80	2.40	4.50	5.10	3.95	1.95	1.35	1.30	1.60	1.60
6	1.90	1.70	2.00	2.60	4.40	5.40	3.95	1.95	1.35	1.30	1.60	1.60
7	1.80	1.80	2.00	2.60	4.30	5.00	3.85	1.95	1.25	1.40	1.60	1.60
8	1.80	2.10	2.40	2.90	4.30	5.10	3.65	1.85	1.25	1.50	1.50	1.60
9	1.80	2.00	2.50	2.90	4.20	5.20	3.75	1.85	1.25	1.60	1.50	1.60
10	1.80	1.90	2.40	3.50	4.20	5.10	3.65	1.85	1.25	1.60	1.50	1.60
11	1.80	1.90	2.20	3.70	4.30	5.00	3.65	1.75	1.25	1.50	1.50	1.60
12	1.80	1.80	2.10	3.90	4.40	4.60	3.55	1.75	1.25	1.50	1.50	1.60
13	1.80	1.80	2.10	4.20	4.50	4.60	3.35	1.75	1.35	1.50	1.50	1.70
14	1.80	1.80	2.10	4.50	4.60	4.50	3.15	1.75	1.25	1.50	1.50	1.70
15	1.80	1.80	2.10	4.90	4.80	4.90	3.05	1.65	1.25	1.50	1.60	1.70
16	1.80	1.80	2.10	4.60	5.00	5.30	2.95	1.65	1.25	1.50	1.60	1.70
17	1.70	1.90	2.00	4.20	5.10	5.70	2.85	1.55	1.25	1.50	1.60	1.70
18	1.70	1.80	2.00	4.00	5.20	5.40	2.75	1.55	1.25	1.50	1.60	1.70
19	1.70	1.80	2.00	4.00	5.30	5.40	2.75	1.55	1.25	1.50	1.60	1.60
20	1.70	1.70	2.00	4.10	5.40	5.00	2.65	1.45	1.25	1.50	1.60	1.60
21	1.70	1.80	2.10	4.00	5.90	4.80	2.75	1.45	1.25	1.50	1.70	1.60
22	1.70	2.10	2.10	4.00	6.30	4.80	2.75	1.45	1.25	1.50	1.70	1.60
23	1.70	2.00	2.10	3.90	7.00	4.70	2.75	1.35	1.25	1.50	1.70	1.60
24	1.80	1.90	2.00	3.80	7.30	4.40	2.75	1.35	1.35	1.50	1.70	1.60
25	1.80	1.90	2.00	3.70	6.40	4.10	2.65	1.35	1.35	1.50	1.70	1.60
26	1.80	1.90	2.00	3.70	5.80	4.00	2.55	1.35	1.25	1.50	1.70	[a]1.80
27	1.70	1.80	1.90	4.30	5.50	3.90	2.45	1.35	1.25	1.50	1.70	1.80
28	1.80	1.80	1.90	4.80	5.40	4.00	2.45	1.35	1.25	1.50	1.70	1.80
29	1.80	1.80	1.90	4.70	5.40	4.10	2.35	1.45	1.25	1.50	1.70	1.80
30	1.80	.....	2.10	4.70	5.30	4.10	2.35	1.55	1.25	1.50	1.70	1.80
31	1.80	.....	2.10	.....	5.40	.....	2.35	1.45	.....	1.50	.....	1.80

[a] Partial ice gorge below, December 26 to 31.

Rating table for Bitterroot River near Grantsdale, Mont., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.30	75	2.40	820	3.50	2,400	5.20	6,050
1.40	100	2.50	930	3.60	2,560	5.40	6,600
1.50	130	2.60	1,050	3.70	2,720	5.60	7,150
1.60	170	2.70	1,180	3.80	2,890	5.80	7,700
1.70	225	2.80	1,320	3.90	3,060	6.00	8,250
1.80	290	2.90	1,470	4.00	3,240	6.20	8,800
1.90	365	3.00	1,620	4.20	3,620	6.40	9,350
2.00	450	3.10	1,770	4.40	4,030	6.60	9,900
2.10	540	3.20	1,925	4.60	4,480	6.80	10,450
2.20	630	3.30	2,080	4.80	4,970	7.00	11,000
2.30	720	3.40	2,240	5.00	5,500		

The preceding table is applicable only for open-channel conditions. It is based upon 7 discharge measurements made during 1904. It is well defined between gage heights 1.30 feet and 6.50 feet. The table has been extended beyond these limits. Above gage height 5.00 feet the rating curve is a tangent, the difference being 275 per tenth.

Estimated monthly discharge of Bitterroot River near Grantsdale, Mont., for 1904.

[Drainage area, 1,550 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	450	225	296	18,200	0.191	0.220
February	540	225	323	18,579	.208	.224
March	930	290	490	30,129	.316	.364
April	5,230	540	2,783	165,600	1.795	2.003
May	11,825	3,620	5,868	360,809	3.786	4.365
June	7,425	3,060	5,208	309,898	3.360	3.749
July	3,335	770	1,899	116,765	1.225	1.412
August	675	88	246	15,126	.159	.183
September	115	65	74	4,403	.048	.054
October	170	55	118	7,256	.076	.088
November	225	130	179	10,651	.115	.128
December [a]	225	170	181	11,129	.117	.135
The year	11,825	55	1,472	1,068,545	.950	12.925

[a] December 26 to 31 estimated on account of ice gage.

BITTERROOT RIVER NEAR MISSOULA, MONT.

This station was established July 6, 1898, by C. C. Babb. The station is located at the Buckhouse wagon bridge, on the main road, 7 miles southwest of Missoula, Mont. As it is not far above its junction with Missoula River, it will give the full discharge of the Bitterroot. The first gage established had a length of wire of 22.83 feet, and the center of the axle of the gage pulley was 3.801 feet below the bench mark. On April 8, 1901, the bridge was washed away, but was immediately replaced. The station was then reestablished with a gage wire of different length. Observations were discontinued November 1, 1901, but were begun again in 1903. The length of the gage wire on October 8, 1903, was found to be 30.40 feet, at which time the center of the gage pulley was 6.70 feet above the United States Geological Survey bench-mark post. The marker on the wire was taken as the end of the wire. April 29, 1904, a standard chain gage replaced the former wire gage. This has a chain length of 25.64 feet. The marker is a brass wire index near its handle. Observations were made during 1904 by Frank Mitchell, Don Buckhouse, and

Frances Coburn. Discharge measurements are made from the downstream guard rail of the wagon bridge to which the gage is attached. The initial point for soundings is a point marked zero over the center of the northeast bridge pier. All distances are marked on the hand rail. The channel is nearly straight above and below the station. The right bank is low and liable to overflow. The left bank is high and rocky and juts out into the river so that the channel is congested at the bridge during floods. The bed of the stream consists of gravel and is shifting. The depth varies from 3 to 6 feet.

The bench mark is a standard United States Geological Survey iron post, set 25 yards northwest of the bridge. Its elevation above gage datum is 19.50 feet, and above sea level (Missoula datum) is 3,140 feet. The center of the old gage pulley has an elevation of 26.20 feet above gage datum. On account of the shifting river bed, which makes accurate rating of the station impossible, this station was abandoned December 31, 1904.

The observations at this station during 1904 have been made under the direction of C. C. Babb, district engineer.

Discharge measurements of Bitterroot River near Missoula, Mont., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
April 28	A. E. Place	226	2,058	4.20	5.26	8,641
May 20	W. B. Freeman	230	2,082	4.75	6.98	9,883
May 28	Murphy and Freeman	230	2,163	4.81	7.18	10,394
June 20	W. B. Freeman	230	1,926	4.55	6.99	8,761
July 9	do	225	1,431	3.23	4.88	4,626
July 21	do	221	1,091	2.22	3.54	2,422
August 25	Freeman and Follansbee.	207	551	.88	1.32	484
November 3	L. R. Stockman	192	693	.97	1.50	674

Mean daily gage height, in feet, of Bitterroot River near Missoula, Mont., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.05	1.65	1.85	2.45	6.00	7.38	5.66	2.80	1.42	1.20	1.45	1.35
2	2.05	1.65	1.85	2.55	6.10	7.18	5.76	2.70	1.42	1.20	1.45	1.35
3	1.95	1.65	1.85	2.55	6.20	7.28	5.56	2.50	1.42	1.20	1.45	1.30
4	1.85	1.55	1.75	2.75	6.20	7.28	5.46	2.40	1.47	1.20	1.45	1.30
5	1.75	1.55	1.75	2.85	6.00	7.28	5.36	2.30	1.47	1.15	1.45	1.25
6	1.65	1.55	1.85	2.95	5.90	7.38	5.46	2.20	1.47	1.15	1.45	1.20
7	1.65	1.55	3.15	3.05	6.00	7.48	5.46	.....	1.47	1.15	1.40	1.20
8	1.65	1.55	3.55	3.05	5.70	.....	4.96	.....	1.32	1.20	1.40	1.20
9	1.65	1.45	3.95	3.05	5.30	.....	4.96	.....	1.32	1.30	1.40	1.25
10	1.55	1.35	3.25	3.65	5.40	.....	4.86	.....	1.32	1.35	1.40	1.30
11	1.55	1.35	2.95	3.85	5.50	.....	4.71	.....	1.32	1.40	1.40	1.35
12	1.65	1.45	2.75	4.75	5.60	.....	4.61	.....	1.32	1.40	1.40	1.35

Mean daily gage height, in feet, of Bitterroot River near Missoula, Mont., for 1904—Cont'd.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
13	1.75	1.55	2.65	5.25	5.60	.....	4.36	.....	1.22	1.40	1.40	1.35
14	1.85	1.55	2.45	5.65	5.60	.....	3.96	.....	1.22	1.40	1.40	1.40
15	1.85	1.55	2.45	6.35	6.00	.....	3.86	.....	1.22	1.40	1.40	1.40
16	1.85	1.65	2.45	6.35	6.30	.....	3.76	.....	1.12	1.40	1.40	1.40
17	1.75	1.75	2.35	5.85	6.40	.....	3.66	.....	1.12	1.40	1.45	1.35
18	1.75	1.65	2.35	5.55	6.60	.....	3.56	.....	1.12	1.45	1.45	1.35
19	1.65	1.65	2.35	5.55	6.80	.....	3.46	.....	1.12	1.45	1.45	1.35
20	1.65	1.65	2.45	5.55	7.10	6.99	3.46	.....	1.12	1.45	1.45	1.35
21	1.65	1.65	2.55	5.65	7.20	.....	3.46	.....	1.12	1.50	1.50	1.35
22	1.55	1.65	2.75	5.75	7.90	.....	3.46	.....	1.12	1.50	1.50	1.30
23	1.55	1.75	2.45	5.85	8.60	.....	3.46	.....	1.12	1.55	1.55	1.30
24	1.65	2.55	2.25	5.65	9.00	.....	3.40	.....	1.12	1.55	1.55	1.30
25	1.65	2.35	1.95	5.05	9.50	5.78	3.40	1.34	1.12	1.55	1.55	1.30
26	1.65	1.85	1.95	5.15	8.62	5.48	3.20	.....	1.12	1.50	1.50	1.30
27	1.65	1.95	1.95	5.35	7.60	5.18	3.20	.....	1.12	1.50	1.50	1.30
28	1.55	1.85	2.05	5.85	7.20	5.18	3.10	1.84	1.12	1.50	1.45	1.35
29	1.55	1.85	2.25	6.80	7.10	5.28	3.00	1.84	1.12	1.50	1.45	1.40
30	1.65	.....	2.45	6.60	7.30	5.48	2.90	1.89	1.17	1.50	1.40	1.45
31	1.65	.....	2.45	.....	7.50	.....	3.00	1.89	.....	1.45	.....	1.50

Rating table for Bitterroot River near Missoula, Mont., from January 1 to December 31, 1904.

Gage height.	Discharge	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.10	370	2.70	1,670	4.30	3,520	6.60	8,460
1.20	440	2.80	1,770	4.40	3,660	6.80	9,140
1.30	510	2.90	1,870	4.50	3,810	7.00	9,820
1.40	580	3.00	1,970	4.60	3,960	7.20	10,500
1.50	650	3.10	2,070	4.70	4,110	7.40	11,180
1.60	720	3.20	2,180	4.80	4,260	7.60	11,860
1.70	790	3.30	2,290	4.90	4,420	7.80	12,540
1.80	870	3.40	2,400	5.00	4,580	8.00	13,220
1.90	950	3.50	2,520	5.20	4,940	8.20	13,900
2.00	1,030	3.60	2,640	5.40	5,340	8.40	14,580
2.10	1,120	3.70	2,760	5.60	5,740	8.60	15,260
2.20	1,210	3.80	2,880	5.80	6,160	8.80	15,940
2.30	1,300	3.90	3,000	6.00	6,620	9.00	16,620
2.40	1,390	4.00	3,120	6.20	7,160	9.20	17,300
2.50	1,480	4.10	3,250	6.40	7,780	9.40	17,980
2.60	1,570	4.20	3,380				

The above table is applicable only for open-channel conditions. It is based upon 8 discharge measurements made during 1904. It is fairly defined between gage heights 1.30 feet and 7.20 feet. The table has been extended beyond these limits. Above gage height 6.40 feet the rating curve is a tangent, the difference being 340 per tenth. There is some uncertainty in the curve due to shifting channel.

Estimated monthly discharge of Bitterroot River near Missoula, Mont.

[Drainage area, 3,260 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	1,075	685	799	49,129	0.245	0.282
February	1,525	545	788	45,326	.242	.261
March	3,060	830	1,434	88,173	.440	.507
April	9,140	1,435	4,592	273,243	1.409	1.572
May	18,320	5,140	9,031	555,294	2.770	3.194
June, 13 days [a]	11,520	4,940	8,397	216,518	2.576	1.245
July	6,050	1,870	3,469	213,300	1.064	1.227
August, 11 days [b]	1,770	545	1,190	25,964	.365	.149
September	615	370	455	27,074	.140	.156
October	685	405	568	34,925	.174	.201
November	685	580	614	36,536	.188	.210
December	650	440	530	32,588	.163	.188
The period				1,598,070		

[a] June 1 to 7 and 25 to 30 inclusive.
[b] August 1 to 6 and 25 and 28 to 31 inclusive.

CLARK FORK [a] AT PRIEST RIVER, IDAHO.

This station was established in June, 1903, by T. A. Noble, assisted by George H. Bliss. It is located about 1,000 feet west of Priest River railroad station and south of the railroad track, on the right bank. It is about 100 feet west of a sawmill. The stream at this point flows parallel to the railroad track, and both the platform to which the gage is attached and the ferry cable from which measurements are made are at right angles to the track and stream. The gage is of the wire and weight type, with horizontal scale board, fastened to the railing of the platform, which is built between two cottonwood and two black pine trees. The gage is adjusted to read the height of the water surface above sea level. Discharge measurements are made from a ferry cable about 400 feet downstream from the gage. The initial point for soundings is a stake on the left bank of the stream and the west side of the driveway. Its elevation is 2,062.11 feet above sea level. On the right bank 1,020 feet from the initial point is another stake, with a tack in its head. Its elevation above sea level is 2,076.31 feet. The channel is straight for about 2,000 feet above and 4,000 feet below the station. The right bank is high, covered with underbrush, and not subject to overflow. The left bank is low, cleared, and liable to overflow. From the top of the left bank there is an upward slope of about

[a] Formerly called Pend Oreille River.

10 per cent. The water flows in one channel, and the bed of the stream is composed of sand, with occasional bowlders. The bench mark from which all elevations were obtained is the United States Geological Survey bench mark south of Priest River station, at the northeast corner of the hotel. Its elevation above sea level is 2,077 feet. A second bench mark, under the gage board platform, is at an elevation of 2,066.19 feet above sea level. A third, on a stump near the gage, is at an elevation of 2,073.02 feet above sea level. On July 16, 1903, the length of the gage wire from the end of the weight to the marker was measured and found to be 32.60 feet. On the bridge rail on the opposite side from the gage 2 copper tacks were driven 32.60 feet apart, to be used for future checking of the length of the wire by the observer.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Clark Fork at Priest River, Idaho, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
March 12	C. E. Hewett	790	5,715	2.50	44.39	14,260
May 27	W. G. Steward	948	16,740	5.34	56.00	89,420
July 20	do	905	10,560	4.28	49.92	45,340
August 11	do	845	7,234	3.13	46.33	22,770

Mean daily gage height, in feet, of Clark Fork at Priest River, Idaho, for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	44.50	43.60	43.50	44.25	52.15	56.30	53.40	47.75	44.40	43.20	42.80	42.80
2	44.45	43.60	43.50	44.30	52.50	56.40	53.25	47.55	44.40	43.15	42.80	42.80
3	44.45	43.70	43.50	44.35	52.75	56.30	53.10	47.40	44.35	43.10	42.80	42.75
4	44.45	43.75	43.50	44.20	52.85	56.40	52.85	47.30	44.30	43.20	42.85	42.80
5	44.35	43.70	43.50	44.35	53.20	56.40	52.65	47.15	44.30	43.15	42.75	42.75
6	44.30	43.70	43.50	44.40	53.45	56.30	52.50	47.00	44.20	43.10	42.75	42.75
7	44.30	43.70	43.60	44.55	53.50	56.40	52.30	46.85	44.15	43.10	42.75	42.70
8	44.30	43.70	43.70	44.70	53.65	56.40	52.15	46.70	44.10	43.05	42.70	42.75
9	44.10	43.60	43.75	44.80	53.65	56.40	51.90	46.50	44.05	43.10	42.75	42.70
10	44.30	43.70	44.10	44.90	53.60	56.20	51.70	46.40	44.00	43.10	42.75	42.65
11	44.25	43.55	44.25	45.00	53.60	56.20	51.50	46.30	43.95	43.10	42.75	42.70
12	44.20	43.50	44.40	45.40	53.65	56.20	51.30	46.15	43.90	43.00	42.70	42.65
13	44.10	43.50	44.45	45.90	53.60	56.00	51.15	46.00	43.90	43.05	42.70	42.70
14	44.10	43.55	44.65	46.35	53.65	55.80	50.90	45.90	43.80	43.00	42.65	42.65
15	44.10	43.60	44.50	47.00	53.55	55.70	50.70	45.75	43.80	43.00	42.65	42.55
16	44.10	43.55	44.60	47.55	53.60	55.40	50.60	45.70	43.80	43.00	42.65	42.70
17	44.20	43.55	44.65	48.20	53.65	55.30	50.35	45.60	43.80	42.95	42.60	42.60
18	44.05	43.55	44.50	48.60	53.70	55.10	50.20	45.40	43.75	42.95	42.60	42.70
19	44.15	43.55	44.55	49.00	53.80	55.20	50.00	45.35	43.70	42.90	42.65	42.65
20	44.10	43.50	44.50	49.25	53.80	55.20	49.95	45.30	43.65	42.90	42.70	42.70

Mean daily gage height, in feet, of Clark Fork at Priest River, Idaho, for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
21	44.10	43.50	44.50	49.50	54.10	55.10	49.65	45.20	43.50	42.90	42.85	42.65
22	44.05	43.45	44.55	49.85	54.30	55.00	49.40	45.10	43.45	42.90	42.90	42.65
23	44.05	43.40	44.55	50.10	54.80	54.70	49.20	45.05	43.40	42.85	42.90	42.70
24	43.85	43.50	44.65	50.40	55.10	54.70	49.10	44.95	43.45	42.90	42.95	42.65
25	44.00	43.50	44.45	50.60	55.50	54.60	48.85	44.90	43.40	42.90	42.90	42.60
26	43.95	43.50	44.40	50.80	55.80	54.50	48.70	44.85	43.35	42.85	42.85	42.60
27	43.95	43.50	44.40	50.90	56.00	54.30	48.45	44.80	43.30	42.80	42.90	42.65
28	43.85	43.50	44.40	51.10	56.10	54.10	48.35	44.75	43.30	42.80	42.80	42.60
29	43.80	43.45	44.35	51.45	56.20	53.80	48.20	44.65	43.30	42.80	42.85	42.65
30	43.80	.....	44.20	51.90	56.20	53.60	47.95	44.55	43.25	42.80	42.90	42.65
31	43.80	.....	44.25	.....	56.30	.....	47.80	44.40	.....	42.80	.....	42.70

Rating table for Clark Fork at Priest River, Idaho, from June 26, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
42.00	6,550	43.90	12,250	45.80	21,010	49.20	40,740
42.10	6,770	44.00	12,650	45.90	21,530	49.40	41,980
42.20	6,990	44.10	13,050	46.00	22,050	49.60	43,220
42.30	7,220	44.20	13,470	46.20	23,100	49.80	44,470
42.40	7,460	44.30	13,890	46.40	24,190	50.00	45,750
42.50	7,700	44.40	14,320	46.60	25,310	50.50	49,000
42.60	7,960	44.50	14,760	46.80	26,440	51.00	52,300
42.70	8,230	44.60	15,200	47.00	27,600	51.50	55,600
42.80	8,510	44.70	15,650	47.20	28,760	52.00	59,000
42.90	8,810	44.80	16,110	47.40	29,920	52.50	62,400
43.00	9,110	44.90	16,570	47.60	31,080	53.00	65,900
43.10	9,420	45.00	17,050	47.80	32,250	53.50	69,400
43.20	9,740	45.10	17,530	48.00	33,450	54.00	73,100
43.30	10,070	45.20	18,010	48.20	34,650	55.00	81,000
43.40	10,410	45.30	18,490	48.40	35,850	56.00	89,300
43.50	10,750	45.40	18,990	48.60	37,050	57.00	99,000
43.60	11,110	45.50	19,490	48.80	38,260	58.00	109,800
43.70	11,480	45.60	19,990	49.00	39,500	59.00	121,200
43.80	11,860	45.70	20,490				

The above table is applicable only for open-channel conditions. It is based upon 10 discharge measurements made during 1903, 1904, and 1905. It is well defined between gage heights 42.50 feet and 50.00 feet. The table has been extended beyond these limits.

Estimated monthly discharge of Clark Fork at Priest River, Idaho, for 1903 and 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
1903.				
July	113,700	44,790	73,940	4,568,000
August	43,900	19,390	28,900	1,777,000
September	18,990	14,280	15,790	939,600
October	16,570	14,230	15,490	952,400
November	18,060	15,420	16,090	957,400
December	17,240	15,110	16,500	1,014,000
The period				10,210,000
1904.				
January	14,760	11,860	13,200	811,600
February	11,670	10,410	11,000	632,700
March	15,420	10,750	13,500	830,100
April	58,320	13,470	31,330	1,864,000
May	92,000	60,020	74,540	4,583,000
June	93,000	70,120	85,040	5,060,000
July	68,700	32,250	49,850	3,065,000
August	31,950	14,320	21,500	1,322,000
September	14,320	9,900	11,920	709,300
October	9,740	8,510	9,057	556,900
November	8,960	7,960	8,437	502,000
December	8,510	7,830	8,182	503,100
The year	93,000	7,830	28,130	20,440,000

PRIEST RIVER AT PRIEST RIVER, IDAHO.

This station was established in June, 1903, by T. A. Noble, assisted by G. H. Bliss. It is located at the highway bridge, on the road from the railroad station at Priest River to Priest Lake. The gage is a vertical board nailed to a pile on the downstream side of the right pier of the highway bridge. A ladder is attached to the pier to facilitate reading the gage. It is read once each day by George Young. Discharge measurements are made from the downstream side of the bridge, to which the gage is attached. The initial point for soundings is the bolt at the end of the guard rail at the right bank. A circle has been painted around the bolt. The channel is straight for 500 feet above and for 200 feet below the bridge. Both banks are high, wooded, and not liable to overflow. Extending from

each pier of the single-span bridge to the bank is a breakwater composed of piles faced with planks. These breakwaters make the current sluggish between the piers and the banks. Under the main span of the bridge, a distance of 120 feet, the current is swift. The bed of the stream is composed of gravel.

Bench mark No. 1 is the bolt in the guard rail at the west end of the bridge, which is used as the initial point for soundings. Its elevation is 29.04 feet above the zero of the gage, and 2,079.7 feet above sea level. Bench mark No. 2 is a spike driven in a stump under the right approach to the bridge. Its elevation is 17.48 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Priest River at Priest River, Idaho, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
March 10	C. E. Hewett	115	477	3.01	4.40	1,434
May 3	W. G. Steward	166	906	6.48	7.47	5,882
May 26	Murphy and Steward	129	898	6.40	7.76	5,755
July 21	W. G. Steward	127	504	3.41	4.61	1,720
August 10	do	125	399	2.39	3.70	955
September 16	O. Laurguard	118	307	1.85	2.86	568

Mean daily gage height, in feet, of Priest River at Priest River, Idaho, for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.80	3.65	3.60	4.00	6.60	7.80	5.80	4.10	3.15	2.75	2.70	3.05
2	3.80	3.55	3.65	4.10	6.95	7.90	5.80	4.05	3.15	2.70	2.70	3.00
3	3.80	3.60	3.60	4.15	7.45	7.85	5.70	4.00	3.10	2.70	2.65	3.00
4	3.80	3.65	3.65	4.25	7.45	7.90	5.70	3.95	3.10	2.70	2.65	3.00
5	3.80	3.70	3.65	4.35	7.45	7.80	5.60	3.90	3.05	2.70	2.65	3.00
6	3.75	3.70	3.75	4.75	7.40	7.85	5.45	3.85	3.00	2.70	2.65	2.95
7	3.75	3.70	3.85	4.75	7.35	7.90	5.35	3.85	3.00	2.75	2.65	2.95
8	3.75	3.70	4.15	4.75	7.25	7.90	5.30	3.80	3.00	2.80	2.65	2.95
9	3.75	3.70	4.45	4.80	7.20	7.85	5.20	3.75	2.95	2.80	2.65	2.95
10	3.75	3.65	4.40	4.95	7.15	7.75	5.10	3.70	2.95	2.80	2.65	2.95
11	3.75	3.70	4.40	5.20	7.10	7.70	5.10	3.65	2.90	2.80	2.60	2.95
12	3.75	3.70	4.30	5.45	7.05	7.60	4.95	3.60	2.90	2.75	2.60	3.00
13	3.75	3.70	4.30	5.70	7.00	7.40	5.00	3.60	2.90	2.70	2.60	2.95
14	3.75	3.70	4.25	6.00	7.00	7.30	4.90	3.55	2.90	2.75	2.60	3.00
15	3.80	3.70	4.20	6.50	7.00	7.20	4.90	3.55	2.85	2.70	2.65	3.10
16	3.90	3.70	4.10	6.70	7.00	7.10	4.85	3.50	2.85	2.75	2.70	3.10
17	3.95	3.70	4.30	6.70	7.00	6.95	4.80	3.50	2.85	2.70	2.70	3.10
18	3.95	3.70	4.15	6.60	7.00	6.95	4.75	3.45	2.85	2.70	2.70	3.05
19	3.90	3.65	4.10	6.50	7.15	7.00	4.70	3.45	2.80	2.70	2.70	3.05
20	3.80	3.65	4.15	6.50	7.20	6.95	4.65	3.40	2.80	2.70	2.95	3.05
21	3.85	3.65	4.10	6.60	7.30	6.80	4.60	3.35	2.75	2.70	3.50	3.05

Mean daily gage height, in feet, of Priest River at Priest River, Idaho, for 1904—Cont'd.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
22	3.95	3.65	4.10	6.80	7.45	6.65	4.55	3.35	2.85	2.70	3.45	3.05
23	3.80	3.60	4.05	6.90	7.60	6.60	4.50	3.30	2.85	2.65	3.15	2.95
24	3.80	3.65	4.05	6.90	7.70	6.55	4.45	3.25	2.85	2.65	3.10	3.00
25	3.75	3.65	3.90	6.85	7.75	6.40	4.40	3.25	2.80	2.65	3.05	3.00
26	3.75	3.70	3.90	6.90	7.75	6.20	4.35	3.20	2.75	2.65	3.05	3.00
27	3.70	3.70	3.90	7.10	7.80	6.15	4.30	3.20	2.75	2.65	3.05	3.00
28	3.70	3.60	3.95	7.30	7.80	6.05	4.25	3.20	2.75	2.65	3.05	3.00
29	3.70	3.65	3.95	7.60	7.80	6.00	4.20	3.20	2.75	2.65	3.05	3.00
30	3.65	.....	4.00	7.65	7.80	5.85	4.15	3.20	2.75	2.65	3.05	3.20
31	3.65	.....	4.00	.....	7.80	.....	4.10	3.15	.....	2.70	.....	3.25

Rating table for Priest River at Priest River, Idaho, from June 28, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.50	460	3.90	1,085	5.30	2,480	7.40	5,820
2.60	485	4.00	1,160	5.40	2,600	7.60	6,200
2.70	515	4.10	1,240	5.50	2,720	7.80	6,580
2.80	545	4.20	1,325	5.60	2,850	8.00	6,960
2.90	580	4.30	1,410	5.70	2,980	8.20	7,360
3.00	615	4.40	1,500	5.80	3,120	8.40	7,760
3.10	655	4.50	1,590	5.90	3,260	8.60	8,160
3.20	695	4.60	1,690	6.00	3,400	8.80	8,560
3.30	740	4.70	1,790	6.20	3,700	9.00	8,960
3.40	785	4.80	1,900	6.40	4,020	9.20	9,360
3.50	835	4.90	2,010	6.60	4,350	9.40	9,760
3.60	890	5.00	2,120	6.80	4,700	9.60	10,160
3.70	950	5.10	2,240	7.00	5,060	9.80	10,560
3.80	1,015	5.20	2,360	7.20	5,440		

The above table is applicable only for open-channel conditions. It is based upon 8 discharge measurements made during 1903 and 1904. It is fairly well defined between gage heights 2.80 feet and 7.50 feet. The table has been extended beyond these limits. Above gage height 8.00 feet the rating curve is a tangent, the difference being 200 per tenth.

Estimated monthly discharge of Priest River at Priest River, Idaho, for 1903 and 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
1903.				
July	8,760	1,720	3,854	237,000
August	1,690	956	1,360	83,620
September	1,092	830	926	55,100
October	1,092	820	978	60,140
November	1,316	890	1,033	61,470
December	1,368	1,036	1,188	73,050
The period				570,400
1904.				
January	1,122	920	1,007	61,920
February	950	862	930	53,490
March	1,545	890	1,196	73,540
April	6,295	1,160	3,503	208,400
May	6,580	4,350	5,693	350,000
June	6,770	3,190	5,354	318,600
July	3,120	1,240	2,034	125,100
August	1,240	675	878	53,990
September	675	530	580	34,510
October	545	500	517	31,790
November	835	485	564	33,560
December	718	598	624	38,370
The year	6,770	485	1,907	1,383,000

SPOKANE RIVER AT SPOKANE, WASH.

This gaging station was originally established October 17, 1896, by C. C. Babb, on the Oregon Railroad and Navigation Company's wooden bridge, about 1 mile above the falls, where discharge measurements and gage readings were taken until July 8, 1903. The distance from the end of the weight to the index of the first wire gage was 22.00 feet, and from the zero of the rod to the outside edge of the pulley 1.80 feet. The gage datum was found to be 1,880 feet above sea level by city datum and 1,865 feet by Government datum.

During 1901 new gages and bench marks were established. The bench mark is a railroad spike in an electric-railway pole close to, and on the south side of the railroad track, at the west end of bridge. Its elevation is 1,896.86 feet above city datum, as determined by the Washington Water Power Company, and 1,882.72 feet above Government datum, as determined by the United States Geological

Survey, July 6, 1903, from a Government bench mark at the county court-house in Spokane.

A second wire gage was afterwards established on the north side of the west span of the bridge. The zero of this gage was at an elevation of 1,879.35 feet, coinciding with the position of the zero of the old gage. The distance from the end of the weight of the marker was also 22.00 feet, but the distance from the zero of the rod to the outside of the pulley was only 1.90 feet.

In July, 1903, the wooden bridge was torn out to be replaced by a steel structure, and the second gage board was destroyed. A third wire gage was established July 8, 1903, on the Olive Avenue Bridge, 950 feet below the railroad bridge. It is located on the south side of the bridge, between the fifth and seventh verticals from the west end, just outside a wooden conduit for pipes. It is 22.30 feet between the end of weight and marker.

The bench mark is a railroad spike in the north face of the first telegraph pole west of the west approach to bridge. Its elevation is 1,881.05 feet above Government datum and 17.16 feet above rod datum.

This gage was established with the idea that readings taken at this point would be a continuation of readings taken at the Oregon Railroad and Navigation Company's bridge, as the two gages were made to read the same when the new one was put in place, and both sections are practically the same. For two weeks before the second gage (that on the railroad bridge) was destroyed, simultaneous readings were obtained, which showed no appreciable difference. The slope in the water surface between the two stations was 1.43 feet on July 8, 1904. At all of the above stations near the Oregon Railroad and Navigation Company's bridge, Mr. Z. Taylor, station agent, has been the observer.

On March 30, 1905, the station on the Olive Avenue Bridge was abandoned, and as the new steel bridge of the Oregon Railroad and Navigation Company was no longer considered safe from which to measure the river, on account of the exposure to danger, a new cable station was established about one-half mile above the Mission Street Bridge, or 1 mile above the former stations at the Oregon Railroad and Navigation Company and Olive Avenue bridges. The station is equipped with ⅝-inch cable, stay wire, and tag wire. The gage is vertical and is fastened to the inside of the most easterly pier on the south side of the Mission Street Bridge, one-half mile below the station. It is divided into feet and tenths, and is read once each day by Mr. A. C. Lingle, a carpenter living near the gage. A secondary gage is located about 100 feet above the cable, and is read by the hydrographer, at the time of measurement, to assist in computing areas. The upper portion is vertical and is fastened to a cottonwood

tree; the lower portion is inclined and nailed to pieces buried in the ground. The rod is divided vertically into feet and tenths. The section here is a good one for stream measurements; the bed is composed of gravel and small bowlders and not liable to change. The banks on both sides are high and will not overflow. The current, except at the lowest stages, is swift.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Spokane River at Spokane, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
April 25	W. W. Schlecht	260	4,298	6.12	11.84	26,420
May 13	W. G. Steward	252	3,875	5.50	10.22	21,300
June 3	C. M. Hurlburt	253	3,722	5.10	9.06	18,980
June 15	do	236	3,219	4.19	7.60	13,490
June 20	W. G. Steward	230	3,025	3.87	7.00	11,690
June 27	do	227	2,906	3.36	5.90	9,771
July 5	do	223	2,593	2.91	5.02	7,539
July 12	C. M. Hurlburt	221	2,411	2.82	4.31	6,794
July 22	W. G. Steward	216	2,169	2.11	3.56	4,580
July 30	C. M. Hurlburt	212	1,938	1.89	2.99	3,648
August 8	do	215	2,034	1.68	2.50	3,414
August 20	Price and Hurlburt	214	1,778	1.32	2.08	2,339
August 29	O. Laurgaard	203	1,779	1.10	1.85	1,966
August 29 [a]	do	221	626	3.20	1.84	2,006
September 16	C. Casteel	201	1,696	.96	1.56	1,630
September 22	do	200	1,668	.88	1.47	1,465
September 22 [b]	C. E. Hewett	182	1,111	1.31	1.47	1,458
October 6	do	202	1,651	.85	1.39	1,398
October 20	G. G. Mair	202	1,660	.83	1.42	1,384
October 20	do	202	1,656	.85	1.42	1,400

[a] Olive Avenue Bridge, one-half mile below station. [b] 250 feet below Olive Avenue Bridge.

NOTE.—All measurements, 1904, were taken at cable station, except as noted.

Mean daily gage height, in feet, of Spokane River at Spokane (Olive Avenue Bridge), Wash., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	Day.	Jan.	Feb.	Mar.	Apr.
1	3.65	3.05	3.20	4.75	17	3.10	2.75	5.95	.....
2	3.60	3.00	3.25	4.75	18	3.20	2.75	5.75	.....
3	3.55	3.00	3.25	4.75	19	3.30	2.75	5.65	.....
4	3.50	2.90	3.25	4.90	20	3.35	2.75	5.70	.....
5	3.45	2.90	3.25	5.00	21	3.40	2.75	5.70	.....
6	3.40	2.90	3.35	5.20	22	3.40	2.75	5.70	.....
7	3.40	2.90	3.40	5.40	23	3.40	2.80	5.60	.....
8	3.35	2.80	3.75	5.60	24	3.35	2.85	5.50	.....
9	3.30	2.80	4.50	5.75	25	3.35	2.90	5.40	.....
10	3.25	2.80	5.30	(a)	26	3.30	2.95	5.30	.....
11	3.25	2.75	5.80	.....	27	3.25	3.05	5.15	.....
12	3.25	2.75	5.95	.....	28	3.25	3.10	5.05	.....
13	3.25	2.75	6.00	.....	29	3.20	3.20	4.95	.....
14	3.25	2.75	6.00	.....	30	3.15	.....	4.95	.....
15	3.30	2.70	6.00	.....	31	3.10	.....	4.80	.....
16	3.40	2.70	5.95	.....					

a Discontinued.

NOTE.—Readings approximate—about 5 per cent too large.

Mean daily gage height, in feet, of Spokane River at Spokane (Mission Street Bridge), Wash., for 1904.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	5.50	11.95	9.25	5.50	2.85	1.85	1.45	1.40	1.60
2	.....	5.50	12.00	9.15	5.40	2.85	1.80	1.45	1.40	1.65
3	.....	5.50	11.85	9.10	5.30	2.80	1.80	1.45	1.40	1.70
4	.....	5.60	11.70	9.00	5.20	2.75	1.75	1.45	1.40	1.70
5	.....	5.70	11.60	8.90	5.05	2.70	1.75	1.40	1.40	1.70
6	.....	5.90	11.50	8.75	4.95	2.60	1.75	1.40	1.40	1.70
7	.....	6.10	11.35	8.70	4.85	2.55	1.75	1.40	1.40	1.75
8	.....	6.30	11.20	8.60	4.75	2.55	1.70	1.40	1.40	1.70
9	.....	6.45	11.00	8.55	4.65	2.45	1.70	1.40	1.35	1.70
10	.....	6.60	10.70	8.45	4.50	2.45	1.70	1.40	1.35	1.70
11	.....	6.80	10.50	8.30	4.40	2.40	1.70	1.40	1.35	1.70
12	.....	7.30	10.35	8.15	4.30	2.35	1.65	1.40	1.35	1.70
13	.....	7.90	10.25	8.00	4.25	2.30	1.65	1.35	1.35	1.70
14	.....	8.60	10.15	7.80	4.10	2.30	1.60	1.35	1.35	1.75
15	.....	9.40	10.05	7.65	4.00	2.25	1.60	1.35	1.35	1.75
16	.....	10.30	10.00	7.50	4.00	2.25	1.55	1.35	1.35	1.75
17	.....	11.30	9.90	7.35	3.90	2.20	1.50	1.35	1.40	1.75
18	.....	11.80	9.85	7.30	3.85	2.20	1.50	1.40	1.35	1.75
19	.....	11.90	9.80	7.15	3.80	2.15	1.50	1.40	1.35	1.70
20	.....	11.90	9.85	7.05	3.70	2.10	1.50	1.40	1.35	1.70
21	.....	12.00	9.85	6.95	3.65	2.10	1.45	1.45	1.40	1.65
22	.....	12.10	9.85	6.80	3.55	2.05	1.45	1.45	1.40	1.65
23	.....	12.10	9.90	6.65	3.50	2.00	1.45	1.45	1.40	1.70
24	.....	12.10	10.00	6.50	3.40	2.00	1.45	1.45	1.50	1.70
25	.....	11.90	10.10	6.30	3.35	2.00	1.45	1.45	1.50	1.70
26	.....	11.70	10.10	6.20	3.25	1.95	1.45	1.40	1.55	1.70
27	.....	11.50	9.95	6.00	3.20	1.90	1.45	1.40	1.55	1.70
28	.....	11.45	9.80	5.90	3.10	1.85	1.45	1.40	1.55	1.70
29	.....	11.55	9.60	5.70	3.05	1.85	1.45	1.40	1.60	1.70
30	5.60	11.70	9.50	5.60	3.00	1.85	1.45	1.40	1.60	1.75
31	5.55	.....	9.35	.....	2.95	1.85	.....	1.40	.....	1.80

Rating table for Spokane River at Spokane, Wash., from April 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.00	940	2.70	3,260	4.40	6,280	7.00	11,830
1.10	1,030	2.80	3,420	4.50	6,470	7.20	12,330
1.20	1,130	2.90	3,580	4.60	6,660	7.40	12,850
1.30	1,240	3.00	3,740	4.70	6,850	7.60	13,380
1.40	1,360	3.10	3,910	4.80	7,050	7.80	13,930
1.50	1,490	3.20	4,080	4.90	7,250	8.00	14,490
1.60	1,620	3.30	4,250	5.00	7,450	8.50	15,900
1.70	1,760	3.40	4,420	5.20	7,850	9.00	17,380
1.80	1,900	3.50	4,600	5.40	8,250	9.50	18,980
1.90	2,040	3.60	4,780	5.60	8,660	10.00	20,580
2.00	2,190	3.70	4,960	5.80	9,080	10.50	22,280
2.10	2,340	3.80	5,140	6.00	9,510	11.00	23,980
2.20	2,490	3.90	5,330	6.20	9,950	11.50	25,780
2.30	2,640	4.00	5,520	6.40	10,400	12.00	27,580
2.40	2,790	4.10	5,710	6.60	10,860	12.50	29,380
2.50	2,940	4.20	5,900	6.80	11,340	13.00	31,180
2.60	3,100	4.30	6,090				

The above table is applicable only for open-channel conditions. It is based upon 20 discharge measurements made during 1904. It is well defined between gage heights 1.40 feet and 12.00 feet. The table has been extended beyond these limits. Above gage height 11.00 feet the rating curve is a tangent, the difference being 360 per tenth.

Estimated monthly discharge of Spokane River at Spokane (Olive Avenue Bridge), Wash., for 1904.

[Drainage area, 4,005 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	6,174	4,958	5,459	335,700	1.36	1.57
February	5,172	4,141	4,305	247,600	1.07	1.15
March	12,420	5,172	9,574	588,700	2.39	2.76
April 1-9	11,680	8,896	9,917	177,000	2.48	.830
The period				1,349,000		

NOTE.—Estimates are based on rating curve of station at O. R. & N. Rwy. bridge, 900 feet above, where conditions are nearly the same as at Olive avenue.

Estimated monthly discharge of Spokane River at Spokane (Mission Street Bridge), Wash., for 1904.

[Drainage area, 4,005 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March 30-31	.....	.....	8,608	34,150	2.15	0.160
April	27,940	8,450	18,780	1,117,000	4.69	5.23
May	27,580	18,500	22,120	1,360,000	5.52	6.36
June	18,180	8,660	13,510	803,900	3.37	3.76
July	8,450	3,660	5,706	350,800	1.42	1.64
August	3,500	1,970	2,605	160,200	.650	.749
September	1,970	1,425	1,617	96,220	.404	.451
October	1,425	1,300	1,369	84,180	.342	.394
November	1,620	1,300	1,384	82,360	.346	.386
December	1,900	1,620	1,769	108,800	.442	.510
The period	.....	.....	.....	4,198,000	.....	.....

HANGMAN CREEK AT TEKOA, WASH.

This station was established April 1, 1904, by W. W. Schlecht. It is located at the footbridge across Hangman Creek about 1,000 feet above the mouth of North Fork of Hangman Creek, in the town of Tekoa, Wash. There is a fall of about 2½ feet between the two points. A plain staff gage, graduated to feet and tenths, is attached vertically to the right pile bent of the bridge. It is read once each day by A. C. McLaughlin. Discharge measurements are made from the downstream side of the footbridge to which the gage is attached. The initial point for soundings is the center of a telegraph pole on the right bank, marked with a 20-penny nail and zero. Five-foot intervals are marked on the bridge. The channel is straight for about 75 feet above and 40 feet below the station. The current is sluggish. About 50 feet below the station is the head of a series of rapids. The right bank is fringed with brush, and liable to overflow to the railroad embankment, about 50 feet. The left bank is high, steep, composed of clay, fringed with brush, and not subject to overflow. The bed of the stream is composed of solid rock with earth banks and is not liable to shift. The station may at times be affected by backwater from the North Fork.

Bench mark No. 1 is a standard United States Geological Survey aluminum tablet marked "2537" set in the vertical wall of a brick house on the corner one square north of the bank of Tekoa. Its elevation is 62.11 feet above the zero of the gage. Bench mark No. 2

is the top of the head of a 60-penny spike driven into the telegraph pole at the initial point for soundings. Its elevation is 11.41 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Hangman Creek at Tekoa, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec. feet.*
April 2	W. W. Schlecht	69	383	0.98	4.88	376
April 5	do	68	409	1.17	5.25	480
April 20	W. G. Steward	60	308	.87	4.20	281
May 6	W. W. Schlecht	28	65	1.21	2.17	78
May 16	W. G. Steward	15	21	1.75	1.47	37
May 24	Steward and Murphy	15	17	1.42	1.15	24
June 4	W. W. Schlecht	16	18	1.46	1.45	26
June 22	W. G. Steward	14	12	.71	.74	8
July 16 [a]	do	8	4	1.07	.58	4
July 16 [b]	do	13	10	.41	.58	4
August 29 [c]	do	1	.35	.80	.41	.28
August 29 [a]	do	1.5	.45	1.02	.42	.46

[a] One-half mile below station.
[b] 300 feet above station.
[c] 150 feet above railroad bridge.

Mean daily gage height, in feet, of Hangman Creek at Tekoa, Wash., for 1904.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct	Nov.	Dec.
1	4.90	2.95	1.00	0.60	0.45	0.40	0.40	0.70	0.65
2	4.90	2.90	1.00	.60	.45	.40	.40	.70	.65
3	5.40	2.70	1.05	.60	.45	.40	.40	.70	.65
4	5.40	2.40	1.45	.60	.45	.40	.40	.70	.65
5	5.30	2.20	1.50	.65	.45	.40	.40	.70	.65
6	5.55	2.10	1.35	.65	.45	.40	.40	.65	.65
7	5.30	2.05	1.30	.65	.40	.40	.45	.65	.65
8	4.85	1.95	1.50	.65	.40	.40	.45	.65	.65
9	4.65	1.85	1.55	.65	.40	.40	.50	.65	.70
10	4.90	1.80	1.30	.45	.40	.40	.50	.65	.70
11	5.80	1.90	1.20	.45	.40	.40	.50	.60	.70
12	6.30	1.85	1.15	.45	.40	.40	.60	.55	.70
13	6.20	1.70	1.00	.45	.40	.40	.60	.55	.70
14	6.10	1.60	.95	.45	.40	.40	.60	.55	.75
15	6.20	1.55	1.00	.45	.40	.40	.65	.55	.80
16	6.90	1.50	.95	.50	.40	.40	.65	.60	.90
17	5.75	1.45	.90	.60	.40	.40	.65	.60	.80
18	4.85	1.40	.95	.60	.40	.40	.70	.60	.80
19	4.30	1.40	.95	.60	.40	.40	.70	.60	.80
20	4.30	1.30	.90	.55	.40	.40	.70	.65	.80
21	4.20	1.35	.90	.60	.40	.40	.70	.65	.80
22	4.20	1.25	.75	.55	.40	.40	.70	.70	.80

Mean daily gage height, in feet, of Hangman Creek at Tekoa, Wash, for 1904—Continued.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
23	4.10	1.20	0.75	0.55	0.40	0.40	0.70	0.70	0.80
24	3.80	1.15	1.20	.55	.40	.40	.70	.70	.80
25	3.50	1.10	2.35	1.20	.40	.40	.70	.70	.80
26	3.20	1.00	2.20	1.80	.40	.40	.70	.75	.80
27	3.05	.95	2.15	.45	.40	.40	.70	.75	.80
28	3.25	1.00	2.15	.45	.40	.45	.70	.75	.85
29	3.40	.95	1.10	.45	.40	.45	.70	.70	.85
30	3.20	.95	.60	.45	.40	.45	.65	.70	.90
31	.....	.90	.....	.45	.40	.....	.65	.....	.90

NOTE.—Gage heights affected by opening of floodgate.

Rating table for Hangman Creek at Tekoa, Wash., from April 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.40	0.2	1.40	34	3.00	142	4.50	318
.45	1.0	1.50	38	3.10	150	4.60	335
.50	2.0	1.60	43	3.20	158	4.70	353
.55	3.0	1.70	49	3.30	167	4.80	372
.60	4.5	1.80	55	3.40	177	4.90	392
.65	6.0	1.90	61	3.50	187	5.00	412
.70	7.5	2.00	67	3.60	197	5.10	434
.75	9.0	2.10	73	3.70	207	5.20	456
.80	10.5	2.20	79	3.80	218	5.30	478
.85	12	2.30	86	3.90	230	5.40	500
.90	14	2.40	94	4.00	243	5.50	522
.95	16	2.50	102	4.10	257	5.60	546
1.00	18	2.60	110	4.20	271	5.70	570
1.10	22	2.70	118	4.30	286	5.80	594
1.20	26	2.80	126	4.40	302	5.90	618
1.30	30	2.90	134				

The above table is applicable only for open-channel conditions. It is based upon 12 discharge measurements made during 1904. It is well defined between gage heights 0.40 foot and 5.30 feet. The table has been extended beyond these limits. Above gage height 5.50 feet the rating curve is a tangent, the difference being 24 per tenth.

Estimated monthly discharge of Hangman Creek at Tekoa, Wash., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April	858	146	405	24,100
May	138	14	50.1	3,080
June	79	4.5	29.9	1,779
July	56	1	5.6	344
August	1	.2	.35	22
September	1	.2	.28	17
October	7.5	.2	4.6	283
November	9	3	6.2	369
December	14	6	9.2	566
The period				30,560

HANGMAN CREEK AT POOLE'S RANCH, NEAR TEKOA, WASH.

This station was established September 28, 1904, by T. A. Noble. It is located 4 miles northwest of Tekoa, Wash., one-fourth mile south of highway bridge across Hangman Creek, and 300 feet south of J. M. Poole's farm crossing. A 6-inch hook gage is used once each day by John M. Poole. Discharge measurements are made by means of a weir 14 feet long. The top of the weir is the same height as the top of a nail driven into the plank which forms part of the dead-man for the bench mark, 7 feet upstream from the weir. The channel is straight for about 80 feet above and 25 feet below the station and the current is sluggish. Both banks are about 6 to 8 feet high, lined with brush, and subject to overflow during high water. The bed of the stream is composed of rock, cemented gravel, free from vegetation, and permanent. There is but one channel at low, and two at high water. The bench mark is the top of a 60-penny nail driven into right-of-way post of the Oregon Railroad and Navigation Company, 40 feet east of the weir. Its elevation is 8.627 feet above the top of the weir or iron lip.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Mean daily gage height, in feet, of Hangman Creek at Poole's ranch near Tekoa, Wash., for 1905.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1	.....	0.383	0.364	0.385	17	.....	0.414	0.382	0.744
2	.....	.383	.376	.419	18	.....	.384	.446	.628
3	.....	.362	.375	.386	19	.....	.340	.445	.733
4	.....	.384	.365	.418	20	.....	.444	.463	.688
5	.....	.314	.377	.398	21	.....	.372	.480	.552
6	.....	.345	.365	.388	22	.....	.375	.554	.534
7	.....	.412	.384	.323	23	.....	.395	.610	.533
8	.....	.496	.375	.379	24	.....	.383	.782	.532
9	.....	.460	.383	.323	25	.....	.385	.647	.....
10	.....	.520	.361	.333	26	.....	.387	.589	.....
11	.....	.570	.371	.354	27	.....	.364	.528	.....
12	.....	.563	.393	.437	28	0.347	.354	.491	.....
13	.....	.571	.394	.466	29	.344	.342	.461	.....
14	.....	.620	.394	.518	30	.383	.388	.415	.....
15	.....	.726	.393	.617	31	.....	.386	.....	.....
16	.....	.442	.370	.779					

From September 28 to October 15, inclusive, length of weir, 1.01 feet; from October 16 to November 24, inclusive, length of weir, 3 feet; from November 25 to December 24, inclusive, length of weir, 5 feet.

HANGMAN CREEK (NORTH FORK) AT TEKOA, WASH.

This station was established April 2, 1904, by W. W. Schlecht. It is located at the highway bridge in Tekoa, Wash., on the road leading north. A plain staff gage, graduated to feet and tenths, is fastened vertically to the concrete abutment of the railway bridge on the northern arm of the "Y" of the Oregon Railroad and Navigation Company's tracks, 25 feet upstream from the bridge from which discharge measurements are made. The gage is read once each day by C. J. McLaughlin. Discharge measurements are made from the downstream side of the highway bridge. The initial point for soundings is the center of telegraph pole on the right bank. It is indicated by a 20-penny nail and marked zero. Five-foot intervals are marked on the bridge. The channel is straight for about 60 feet above and below the station and the current is swift. There is a series of rapids between the gaging station and the mouth of the creek, having a total fall of about 4 to 5 feet. The right bank is of earth, fringed with brush, having a number of houses built close to the river, and does not overflow. The left bank is low, and is liable to overflow above and below the station 50 to 100 feet back to the railroad embankment. The bed of the stream is composed of gravel and a few bowlders, and is permanent. At the gaging section there is but one channel at all stages.

Bench mark No. 1 is a United States Geological Survey standard aluminum tablet set in the vertical wall of a brick house on the corner 1 square north of the bank in Tekoa. It is marked "2537" and is 58.29 feet above the zero of the gage. Bench mark No. 2 is a point

on the concrete abutment of the railroad bridge near the gage. Its elevation is 8.39 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Hangman Creek (North Fork) at Tekoa, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
April 2	W. W. Schlecht	44	119	1.71	2.28	203
April 9	do	44	108	1.09	1.88	117
April 20	W. G. Steward	40	93	.38	1.50	37
May 6 [a]	W. W. Schlecht	18	13	.79	1.23	10
May 11 [a]	W. G. Steward	30	2.8	1.36	.80	3.8
May 24 [a]	Murphy and Steward	.....	1.9	.83	.62	1.6
June 22 [a]	W. G. Steward	3	1.9	.35	.42	.67
July 16 [a]	do	3	1.8	.38	.50	.70
August 29 [a]	do	.8	.24	1.17	.42	.28

[a] Not at regular section.

Mean daily gage height, in feet, of Hangman Creek (North Fork) at Tekoa, Wash., for 1904.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.30	0.65	0.40	0.47	0.44	0.44	0.70	0.70
2	2.30	1.40	.70	.47	.47	.44	.44	.70	.70
3	2.35	1.30	1.00	.47	.46	.44	.44	.70	.70
4	2.25	1.20	1.00	.50	.46	.44	.44	.70	.70
5	2.20	1.15	.75	.50	.46	.44	.44	.70	.70
6	2.30	1.20	.75	.47	.46	.44	.44	.70	.70
7	1.94	1.20	.75	.47	.47	.44	.45	.70	.70
8	1.93	1.10	.80	.50	.46	.44	.46	.75	.70
9	1.90	1.00	.70	.50	.46	.44	.50	.70	.70
10	1.90	1.00	.65	.47	.45	.44	.50	.70	.70
11	1.95	1.20	.50	.47	.45	.44	.60	.70	.75
12	1.98	1.00	.55	.46	.45	.44	.60	.70	.75
13	1.80	.90	.60	.47	.45	.44	.60	.70	.76
14	1.70	.90	.55	.47	.46	.44	.60	.70	.76
15	1.90	.80	.43	.47	.46	.44	.60	.70	.77
16	2.00	.80	.50	.50	.45	.44	.65	.70	.85
17	1.70	.77	.50	.60	.45	.44	.66	.70	.80
18	1.70	.77	.50	.50	.44	.44	.70	.70	.85
19	1.50	.80	.50	.50	.44	.44	.70	.70	.85
20	1.30	.85	.45	.50	.44	.44	.70	.75	.85
21	1.30	.77	.45	.50	.43	.44	.70	.75	.85
22	1.70	.70	.45	.47	.43	.44	.70	.75	.85
23	1.70	.70	.40	.47	.43	.44	.70	.75	.85
24	1.50	.55	.40	.47	.43	.44	.70	.67	.80
25	1.50	.40	.40	.50	.43	.44	.70	.70	.80
26	1.40	.40	.90	.50	.44	.44	.70	.70	.80
27	1.40	.40	.40	.50	.44	.44	.70	.70	.90
28	1.45	.50	.35	.50	.44	.44	.70	.70	.98
29	1.40	.35	.40	.50	.44	.44	.65	.70	.98
30	1.40	.50	.40	.50	.44	.44	.65	.70	.98
31	.....	.50	.....	.47	.44	.....	.65	.....	.99

Rating table for Hangman Creek (North Fork) at Tekoa, Wash., from April 2 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.35	0.1	.80	3.5	1.25	10.6	1.90	121
.40	.2	.85	4.0	1.30	13.0	2.00	142
.45	.4	.90	4.6	1.35	16.4	2.10	163
.50	.7	.95	5.4	1.40	21.4	2.20	184
.55	1.0	1.00	6.2	1.45	29	2.30	205
.60	1.5	1.05	7.0	1.50	37	2.40	226
.65	2.0	1.10	7.8	1.60	58		
.70	2.5	1.15	8.6	1.70	79		
.75	3.0	1.20	9.4	1.80	100		

The above table is applicable only for open-channel conditions. It is based upon 9 discharge measurements. It is well defined between gage heights 0.30 foot and 2.30 feet. The table has been extended beyond these limits. Above gage height 2.40 the rating curve is a tangent, the difference being 22 per tenth.

Estimated monthly discharge of Hangman Creek (North Fork) at Tekoa, Wash., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April 2-30	215	21.4	95.8	5,510
May	21.4	.1	5.23	322
June	6.2	.1	1.61	96
July	1.5	.2	.62	38
August	.5	.3	.42	26
September	.4	.4	.40	24
October	2.5	.4	1.61	99
November	3.0	2.2	2.57	153
December	6.0	2.5	3.57	220
The period				6,488

LITTLE SPOKANE RIVER NEAR SPOKANE, WASH.

This station was established August 3, 1903, by George H. Bliss. It is located about 2 miles above the mouth of the river at the second bridge above the mouth. It is 9 miles northwest of Spokane, Wash., and 1½ miles northeast of what is known as the "9-mile bridge" over Spokane River. The wire gage is located on the upstream side of the bridge. The center of the pulley is 105 feet from the south end of the bridge. The length of the wire from the end of the weight to the

marker is 13.25 feet. This distance has been laid off on the upper surface of the bottom rail near the gage and is marked by copper tacks inclosed in circles of black paint. These marks are used in checking the length of the gage wire. The gage is read once each day by Mary A. Keenan. Discharge measurements are made from the upstream side of the bridge to which the gage is attached. The initial point for soundings is the vertical end post on the upstream side of the bridge at the south approach. The channel is straight for 100 feet above and 150 feet below the station. The current is swift. Both banks are high, covered with underbrush, and liable to overflow only at very high stages. The bed of the stream is composed of clean gravel. The channel is broken by four bridge piers and has a width at ordinary stages of about 125 feet. The bench mark is a wire nail driven into the root of a black pine tree 2 feet in diameter. The root is on the north side of the tree and extends toward the bridge. It is 60 feet distant from the south end of the bridge. The tree is blazed. It is marked "B. M." with black paint. The bench mark has an elevation of 21.00 feet above gage datum.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Little Spokane River near Spokane, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
March 3	G. H. Bliss	134	544	1.54	8.90	838
April 19	W. G. Steward	122	801	3.02	10.98	2,416
May 20	Steward and Murphy	102	546	1.56	8.48	850

Mean daily gage height, in feet, of Little Spokane River near Spokane, Wash., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.60	6.68	7.50	8.95	10.60	7.33	6.60	6.10	6.09	6.10	6.35	6.30
2	6.60	6.65	7.35	8.94	9.82	7.40	6.50	6.30	6.15	6.29	6.30	6.34
3	6.60	6.57	7.10	8.91	9.76	7.50	6.40	6.20	6.20	6.30	6.29	6.20
4	6.65	6.65	7.10	9.15	9.60	7.40	6.70	6.20	6.15	6.10	6.25	6.27
5	6.68	6.74	7.30	9.56	9.62	7.45	7.35	6.18	6.20	6.15	6.18	6.28
6	6.50	6.90	7.55	9.90	9.55	7.60	7.32	6.30	6.01	6.23	6.24	6.19
7	6.60	6.75	7.90	10.20	9.40	7.70	7.40	6.21	6.04	6.30	6.30	6.30
8	6.55	6.80	8.60	10.15	9.35	7.04	7.45	6.20	6.00	6.05	6.20	6.25
9	6.62	6.70	9.55	10.05	9.32	7.50	7.32	6.19	6.01	6.19	6.30	6.34
10	6.70	6.50	9.55	10.20	9.21	7.34	6.40	6.24	6.03	6.18	6.34	6.40
11	6.68	6.64	9.40	10.50	9.16	7.24	6.45	6.30	6.10	6.20	6.35	.....
12	6.70	6.70	9.30	10.85	9.00	7.10	6.50	6.20	6.01	6.19	6.37	.....
13	6.78	6.80	9.25	10.90	8.96	7.00	6.40	6.17	6.00	6.20	6.30	.....
14	6.78	6.75	9.30	11.00	8.84	7.05	6.20	6.20	5.99	6.10	6.25	.....
15	6.80	6.78	9.25	11.30	8.82	6.85	6.30	6.15	5.99	6.23	6.40	.....
16	6.80	6.76	9.30	[a]12.00	8.00	6.82	6.40	6.20	6.01	6.25	6.10	.....

[a] Highest water in 17 years, according to observer.

Mean daily gage height, in feet, of Little Spokane River near Spokane, Wash., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
17	7.05	6.90	9.20	11.70	8.76	6.75	6.50	6.15	6.00	6.09	6.29	.....
18	7.10	6.80	9.15	11.20	8.68	6.50	6.40	6.20	6.13	6.10	6.50	.....
19	7.05	6.70	9.20	11.00	8.53	6.60	6.30	6.05	6.00	6.08	6.27	.....
20	6.85	6.90	9.20	10.94	8.30	6.50	6.45	6.16	6.20	6.00	6.39	.....
21	6.80	6.70	9.25	10.60	8.15	6.50	6.20	6.18	6.25	6.16	6.40	.....
22	6.89	6.90	9.15	10.55	8.20	6.65	6.32	6.15	6.30	6.39	6.25	.....
23	6.85	7.50	9.10	10.42	8.13	6.70	6.48	6.13	6.20	6.40	6.30	.....
24	6.67	7.11	9.05	10.35	8.10	6.60	6.32	6.17	6.00	6.20	6.28	.....
25	6.65	7.15	9.00	10.20	8.00	6.55	6.00	6.10	6.29	6.50	6.30	.....
26	6.65	7.25	8.85	10.07	7.95	6.50	6.15	6.08	6.18	6.48	6.45	.....
27	6.67	7.40	8.64	10.17	7.90	6.45	6.30	6.15	6.23	6.69	6.30	.....
28	6.71	7.60	8.73	10.00	7.81	6.30	6.20	6.12	6.20	6.29	6.25	.....
29	6.68	7.60	8.70	9.95	7.70	6.35	6.20	6.27	6.10	6.20	6.29	.....
30	6.78	.....	9.00	10.00	7.30	6.60	6.18	6.13	6.15	6.15	6.34	.....
31	6.78	.....	8.48	.....	7.28	.....	6.15	6.10	.....	6.20	.....	.....

SINLAHEKIN CREEK NEAR LOOMIS, WASH.

This station was established June 13, 1903, by Charles E. Hewitt. It is located on the main road between Loomis and Conconully, Wash., 3 miles from Loomis and 19 miles from Conconully. The gage is a vertical staff driven into the ground and braced to the gatepost at the northeast corner of R. A. Garrett's yard. Mrs. Mary Garrett, the observer, reads the gage once each day. There is a highway bridge 500 feet north of Mr. Garrett's house, but discharge measurements are made from a plank footbridge near the gage. The initial point for soundings is a 1 by 2 inch iron bar 15 feet long driven flush with the ground at the northeast corner of the main part of Mr. Garrett's house, and 50 feet from the gage. The channel is straight for 20 feet above and for 50 feet below the station. Beyond these points are large bends in the stream. The right bank is low for about 15 feet back from the water's edge. Beyond this point it is not subject to overflow, as it rises more abruptly. The water's edge is covered with shrubbery. The left bank is low grass land, subject to overflow. The bed of the stream is a gravelly clay or loam, and is quite stable. The bench mark is the top of the iron bar used as the initial point for sounding. Its elevation is 11.40 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Mean daily gage height, in feet, of Sinlahekin Creek near Loomis, Wash., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.5	3.0	2.7	2.9	7.7	6.0	3.6	2.7	2.6	2.5	2.8	2.8
2	2.5	3.0	2.6	3.2	7.5	5.9	3.5	2.6	2.6	2.5	2.8	2.8
3	2.4	3.2	2.6	3.5	7.5	5.8	3.4	2.6	2.5	2.5	2.8	2.8
4	2.4	3.2	2.6	3.5	7.4	5.8	3.4	2.6	2.5	2.5	2.8	2.8
5	2.4	3.3	2.5	3.5	7.3	5.8	3.3	2.6	2.5	2.5	2.8	2.8
6	2.4	3.0	2.4	3.3	6.9	5.7	3.2	2.6	2.5	2.5	2.8	2.7
7	2.5	2.8	2.4	3.0	6.7	5.6	3.2	2.6	2.5	2.5	2.8	2.7
8	2.5	2.8	2.6	2.9	6.7	5.5	3.3	2.6	2.5	2.5	2.8	2.7
9	2.5	2.8	3.0	2.9	6.6	5.3	3.2	2.5	2.5	2.5	2.8	2.7
10	2.6	3.0	2.6	2.9	6.6	5.2	3.2	2.5	2.5	2.6	2.8	2.7
11	2.8	3.5	2.5	3.0	6.6	5.0	3.1	2.5	2.5	3.3	2.8	2.7
12	2.7	4.0	2.5	3.3	6.6	4.8	3.5	2.5	2.5	3.6	2.8	2.7
13	2.6	3.8	2.5	3.8	6.5	4.8	3.0	2.5	2.5	3.0	2.8	2.7
14	2.6	3.7	2.5	4.0	6.6	4.5	3.0	2.5	2.5	2.9	2.8	2.7
15	2.6	3.6	2.5	4.7	6.8	4.5	3.0	2.5	2.5	2.8	2.9	2.7
16	2.6	3.5	2.5	7.3	6.9	4.4	3.2	2.5	2.5	2.8	3.0	2.7
17	2.8	3.4	2.5	7.6	7.0	4.4	3.1	2.5	2.5	2.7	3.0	2.7
18	2.8	3.4	2.4	6.8	7.0	4.5	3.0	2.5	2.5	2.7	2.9	2.7
19	2.5	3.4	2.4	6.7	7.1	5.8	3.0	2.5	2.5	2.7	2.8	2.7
20	2.5	3.0	2.4	6.8	7.3	4.8	2.9	2.5	2.5	2.7	2.8	2.7
21	2.6	3.5	2.4	6.8	7.6	4.6	2.8	2.5	2.5	2.7	2.8	2.7
22	2.6	3.6	2.4	7.2	7.6	4.4	2.8	2.5	2.5	2.7	2.8	2.7
23	2.6	3.6	2.4	7.2	7.5	4.2	2.8	2.5	2.5	2.7	2.8	2.7
24	2.6	3.6	2.4	7.0	7.4	4.1	2.8	2.5	2.5	2.7	2.8	2.7
25	2.7	3.6	2.4	6.7	7.0	4.0	2.8	2.5	2.5	2.7	2.8	2.7
26	2.8	3.7	2.4	6.8	6.7	3.9	2.8	2.5	2.5	2.7	2.8	2.7
27	2.8	3.5	2.4	7.0	6.6	3.8	2.8	2.5	2.5	2.7	2.8	2.7
28	2.8	3.3	2.4	7.7	6.5	3.7	2.7	2.6	2.5	2.7	2.8	2.7
29	2.7	2.8	2.4	(a)	6.4	3.6	2.7	2.7	2.5	2.7	2.8	2.8
30	2.6	.....	2.5	8.0	6.3	3.6	2.7	2.7	2.5	2.7	2.8	2.8
31	2.6	.....	2.7	.....	6.0	.....	2.7	2.6	.....	2.7	.....	2.7

[a] Water above gage.

Rating table for Sinlahekin Creek near Loomis, Wash., from June 13, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.60	4.5	2.40	11	3.20	34	3.90	62
1.70	5	2.50	13	3.30	37	4.00	66
1.80	5.5	2.60	16	3.40	41	4.10	72
1.90	6	2.70	19	3.50	45	4.20	77
2.00	6.5	2.80	22	3.60	49	4.30	82
2.10	7	2.90	25	3.70	53	4.40	87
2.20	8	3.00	28	3.80	57	4.50	92
2.30	9	3.10	31				

The above table is applicable only for open-channel conditions. It is based upon 4 discharge measurements made during 1903. It is well defined between gage heights 2.40 feet

and 4.10 feet. The table has been extended beyond these limits. Above gage height 3.90 feet the rating curve is a tangent, the difference being 5 per tenth.

Estimated monthly discharge of Sinlahekin Creek near Loomis, Wash., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January	22	11	15.8	972
February	66	22	39.2	2,255
March	28	11	13.3	818
April	266	25	133	7,914
May	251	166	21.3	1,310
June	166	49	106	6,307
July	49	19	29.4	1,808
August	19	13	14.3	879
September	16	13	13.2	786
October	49	13	19.1	1,174
November	28	22	22.1	1,315
December	22	19	19.2	1,181
The year	266	11	37.2	26,720

JOHNSON CREEK NEAR RIVERSIDE, WASH.

This station was established by T. A. Noble, May 30, 1903. It is located at Sogle's ranch, on the road from Riverside to Conconully, 1 mile from Riverside and 17 miles from Conconully. The equipment consists of a sharp crested weir with an 8-foot opening and vertical sides. Below the level of the crest the weir consists of two 2-inch pine planks, 12 inches wide, securely spiked together. Above the crest on each end are two planks 12 inches wide, which form the ends of the weir. The edges of the crest and ends are one-fourth inch wide and beveled on the downstream side to an angle of 60°. The pool above the weir is 10 feet long, 10 to 15 feet wide, and 1 foot deep below the crest. The water has a fall of about 1 foot after passing the weir and then flows rapidly away.

The depth of water on the crest is determined by a hook gage and vernier reading to thousandths of a foot. The zero on the gage is level with the crest of the weir. Readings are made once each day by S. Sogle. The right bank of the stream is low for 10 feet back from the water's edge and then it rises more abruptly. The left bank is steep and rocky. The bed of the creek is composed of small gravel. Bench mark No. 1 is the top of the fence post opposite the weir. Its elevation is 19.12 feet above gage datum. Bench mark No. 2 is a nail driven into a stake 3 feet northwest of the weir. Its elevation is 0.29

foot above gage datum. The weir was destroyed July 30, 1904, and the station discontinued.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Mean daily gage height, in feet, of Johnson Creek near Riverside, Wash., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	0.38	0.32	0.40	0.62	0.68	0.44	0.45
2	.37	.31	.39	.65	.66	.48	.48
3	.38	.32	.36	.68	.62	.48	.45
4	.38	.32	.40	.74	.63	.47	.42
5	.37	.32	.40	.77	.63	.46	.42
6	.38	.38	.40	.78	.61	.46	.44
7	.39	.38	.45	.71	.65	.46	.44
8	.40	.34	.44	.68	.63	.45	.45
9	.40	.31	.44	.65	.60	.43	.45
10	.41	.31	.45	.69	.61	.43	.46
11	.43	.32	.50	.70	.61	.45	.46
12	.38	.33	.50	.67	.59	.45	.46
13	.39	.34	.51	.67	.55	.44	.46
14	.39	.24	.50	.67	.54	.44	.48
15	.41	.30	.47	.76	.52	.42	.52
16	.44	.34	.46	.78	.52	.43	.52
17	.43	.34	.46	.74	.50	.42	.52
18	.41	.35	.45	.71	.48	.54	.50
19	.32	.38	.45	.78	.47	.56	.49
20	.37	.38	.45	.78	.46	.48	.48
21	.35	.37	.50	.79	.44	.48	.48
22	.36	.38	.52	.79	.45	.47	.48
23	.36	.33	.52	.79	.48	.49	.45
24	.36	.38	.50	.73	.48	.48	.45
25	.34	.37	.49	.72	.49	.47	.44
26	.34	.39	.49	.72	.48	.48	.44
27	.33	.40	.48	.68	.46	.50	.44
28	.32	.40	.51	.64	.47	.51	.45
29	.33	.39	.57	.69	.45	.49	.45
30	.32	.....	.53	.66	.43	.48	[a] .45
31	.32	.....	.61	.....	.44	.....	[a] .45

[a] Estimated.

Rating table for Johnson Creek near Riverside, Wash., from May 29 to December 31, 1904.[a]

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.1	0.9	0.4	6.7	0.7	15.3	1.0	26.0
.2	2.4	.5	9.3	.8	18.7	.....	.....
.3	4.4	.6	12.2	.9	22.3	.....	.....

[a] The computations for the rating table were based on the formula for contracted weirs.

Gage heights give directly depth of water over weir.

Estimated monthly discharge of Johnson Creek near Riverside, Wash., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January	7.7	4.9	6.10	375
February	6.7	3.2	5.47	315
March	12.5	5.8	8.58	528
April	18.4	12.8	15.9	946
May	14.7	7.5	10.4	640
June	11.0	7.2	8.48	505
July	9.9	7.2	8.33	512
The period				3,821

SALMON CREEK NEAR MALOTT, WASH.

This station was established April 11, 1903, by T. A. Noble. It is located opposite R. D. Jones's house, which is on the county road halfway between Malott and Conconully, Okanogan County. It is reached by way of the Great Northern Railway to Wenache, thence by way of the Columbia River steamers to Brewster, and by the Conconully stage from Brewster to Jones's ranch. The gage is vertical and consists of a 1 by 6 inch board graduated to feet and inches, and fastened to a small alder tree on the left bank of the river opposite the house of the observer, R. D. Jones, who reads the gage once each day. Discharge measurements are made from the footbridge just above the gage. The initial point for soundings is a large nail driven in a birch hub, 8 inches in diameter and 2 feet long, 4 feet east of the bridge and 14 feet north of the gage. It is on the left bank, 7 feet from the water's edge at ordinary stages. The channel is straight for 100 feet above and for 200 feet below the station. There are rapids at the bend in the river 100 feet above the station and at another bend 300 feet below the station. The current is swift. The right bank is low and will overflow for about 100 feet, at which point it becomes steep. The left bank is low and may overflow for 200 feet at extreme flood stages. Both banks are without trees or brush with the exception of a fringe of alder at the water's edge. The bed is rocky at the center and sandy along the banks. It is without vegetation except near the banks. The bench mark is the initial point for soundings. Its elevation is 4.58 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Salmon Creek near Malott, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
March 23	G. H. Bliss	18	28	0.62	0.82	17
July 2	W. W. Schlecht	21	33	1.17	1.12	38

Mean daily gage height, in feet, of Salmon Creek near Malott, Wash., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.71	0.67	0.65	0.82	3.12	2.67	1.66	0.84	0.91	0.67	0.82	0.87
2	.93	.75	.58	.87	3.18	2.50	1.56	.85	.94	.71	.83	.85
3	.83	.77	.67	.96	3.17	2.54	1.54	.83	.92	.66	.83	.85
4	.69	.75	.79	1.02	3.00	2.52	1.50	.77	.91	.60	.83	.84
5	.67	.71	.74	1.00	2.34	2.50	1.46	.75	.85	.60	.82	.84
6	.85	.67	.75	1.08	2.44	2.63	1.48	.77	.82	.67	.82	.83
7	.83	.69	.77	1.04	2.54	2.58	1.42	.74	.79	.63	.83	.83
8	.60	.75	.83	1.08	2.58	2.33	1.49	.67	.75	.60	.83	.83
9	.72	.58	.81	1.17	2.59	2.33	1.42	.83	.75	.67	.83	.84
10	.79	.69	.77	1.30	2.57	2.21	1.38	.82	.79	.69	.82	.84
11	.67	.67	.79	1.42	2.54	2.15	1.29	.88	.77	1.33	.81	.83
12	.83	.75	.75	1.54	2.58	2.08	1.29	1.00	.79	1.27	.82	.83
13	.71	.67	.69	1.70	2.60	2.04	1.23	1.04	.75	1.29	.83	.84
14	.81	.77	.75	2.83	2.69	2.08	1.21	1.00	.79	1.00	.83	.84
15	.67	.75	.71	2.53	2.75	2.10	1.19	.99	.77	.96	.94	.85
16	.83	.77	.99	2.09	2.71	2.08	1.23	.96	.75	.88	.98	.84
17	.87	.79	1.00	2.58	2.67	2.06	1.21	.94	.76	.92	1.02	.84
18	.67	.75	.99	2.50	2.71	2.21	1.18	.96	.75	.94	1.00	.83
19	.83	.74	.92	2.54	2.79	2.38	1.17	.92	.69	.87	.92	.83
20	.58	.69	.81	2.67	2.83	2.13	1.09	.96	.74	.83	.92	.82
21	.71	.69	.85	2.75	3.04	2.04	1.08	.94	.77	.85	.91	.80
22	.80	.75	.83	2.96	3.21	1.94	1.04	.93	.71	.91	.92	.79
23	.79	.69	.82	2.75	3.08	1.83	1.00	.94	.75	.88	.90	.75
24	.79	.75	.67	2.75	2.92	1.79	.99	.96	.71	.79	.90	.71
25	.79	.67	.64	2.71	2.75	1.76	.98	.83	.67	.79	.89	.....
26	.73	.71	.62	2.94	2.79	1.75	1.00	.88	.69	.82	.89	.....
27	.75	.73	.67	3.28	2.75	1.72	.92	.83	.67	.83	.88	.....
28	.67	.79	.69	3.58	2.71	1.69	.91	.83	.71	.79	.88	.....
29	.79	.69	.82	3.63	2.67	1.67	.92	.85	.62	.77	.87	.....
30	.71	.....	.75	3.27	2.58	1.64	.90	.88	.58	.79	.86	.....
31	.71	.....	.79	.....	2.59	.....	.88	.92	.....	.81	.....	.....

Rating table for Salmon Creek near Malott, Wash., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.6	11	1.3	57	2.0	166	2.6	292
.7	13	1.4	71	2.1	183	2.7	318
.8	16	1.5	86	2.2	202	2.8	345
.9	20	1.6	102	2.3	222	2.9	373
1.0	27	1.7	118	2.4	244	3.0	401
1.1	35	1.8	134	2.5	267	3.1	429
1.2	45	1.9	150				

The above table is applicable for open-channel conditions only. It is based on discharge measurements made during 1903 and 1904. It is well defined between 0.85 foot and 3.14 feet gage height. It has been extended below 0.85 foot.

Estimated monthly discharge of Salmon Creek near Malott, Wash., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January	22	11	14.7	904
February	16	11	13.5	777
March	27	11	15.7	965
April	577	17	224.	13,330
May	451	231	332.	20,410
June	310	108	195.	11,600
July	112	19	51.1	3,142
August	30	12	20.0	1,230
September	22	11	15.1	898
October	61	11	20.1	1,236
November	29	16	19.3	1,148
December (1-24)	19	13	17.2	819
The period				56,460

METHOW RIVER NEAR PATEROS, WASH.

Methow River has its source in the Cascade Mountains near the boundary line between the United States and British Columbia, and flows in a southeast direction into Columbia River. The stream is a very rapid one, and is at present used to a considerable extent for irrigation purposes.

The gaging station was originally established May 3, 1903, by T. A. Noble, and was located upon a highway bridge about 1,000 feet above the mouth of the river. The first two measurements were taken from

this bridge. During the summer of 1903 this bridge was washed away, and a temporary bridge, 400 feet farther down stream was used in making the measurement of March 20, 1904.

During the spring of 1904, this bridge was also abandoned because of its temporary nature and the poor section at this point, and a cable station was established about a mile above the mouth of the river where a very good section exists for taking measurements, except at the highest stage of the river. At such times the current at the station becomes too swift to measure, and it is necessary to use a boat farther down the stream, where the backwater from Columbia River retards the current.

The gage is located about 500 feet below the cable, and above any effect of backwater from Columbia River. It is fastened between two pine trees on the left bank. The lower section is inclined and reads from 0 to 10 feet. The upper section is vertical and reads from 10 to 19 feet. Both sections are divided into feet and tenths. All gage heights given below and all discharge measurements are referred to this gage. A secondary gage is in place at the cable to be used by the hydrographer at the time of measurement, to assist in computing areas.

Both banks at the station are high and not liable to overflow. The bed of the stream is covered with small bowlders and gravel and is liable to slight changes. The initial point for soundings is a cross marked "I. P." on rock about 10 feet back of shear legs on left bank.

Bench mark No. 1 is a United States Geological Survey standard iron post in front of Ives Hotel, at Pateros, Wash. Its elevation is 26.05 feet above zero of the gage and 780 feet above sea level. Bench mark No. 2 is the top of a large white stone, marked "B. M.," which is 30 feet northeast of gage board on left bank. Elevation of the highest point is 15.20 feet above gage datum.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Methow River near Pateros, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
March 20 [a]	G. H. Bliss	66	124	3.82	4.20	474
June 10 [b]	W. G. Steward	250	2,631	2.77	8.80	7,293
July 1	C. M. Hurlburt	245	2,041	3.81	8.60	7,790
July 30 [b]	W. G. Steward	170	534	2.56	5.39	1,368

[a] Made at temporary bridge. [b] Made at new cable station.

Mean daily gage height, in feet, of Methow River near Pateros, Wash., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.60	4.30	4.30	4.20	9.00	9.30	8.50	5.30	4.50	4.10	4.15	4.20
2	4.55	4.35	4.30	4.20	8.75	9.25	8.60	5.30	4.50	4.10	4.15	4.20
3	4.50	4.45	4.25	4.25	8.50	9.20	8.20	5.20	4.45	4.10	4.15	4.20
4	4.50	4.50	4.25	4.25	8.40	9.15	8.20	5.15	4.45	4.10	4.15	4.20
5	4.50	4.50	4.25	4.30	8.30	9.30	8.10	5.15	4.45	4.10	4.15	4.20
6	4.50	4.50	4.25	4.35	8.05	9.50	8.10	5.10	4.40	4.10	4.15	4.20
7	4.55	4.50	4.25	4.40	7.85	9.60	8.20	5.10	4.40	4.10	4.15	4.20
8	4.55	4.45	4.25	4.45	7.75	9.20	7.90	5.05	4.35	4.10	4.15	4.20
9	4.55	4.40	4.25	4.50	7.60	8.75	7.60	5.05	4.30	4.10	4.15	4.20
10	4.50	4.40	4.25	4.65	7.60	8.85	7.40	4.95	4.30	4.50	4.15	4.20
11	4.50	4.45	4.25	4.90	7.60	8.50	7.30	4.85	4.30	4.50	4.15	4.20
12	4.50	4.55	4.25	5.40	7.60	8.50	7.20	4.80	4.30	4.40	4.15	4.20
13	4.50	4.50	4.20	6.25	7.65	8.50	6.90	4.80	4.30	4.30	4.15	4.20
14	4.50	4.60	4.20	7.00	7.90	8.50	6.55	4.75	4.25	4.30	4.15	4.25
15	4.55	4.60	4.20	8.20	7.90	8.20	6.40	4.70	4.25	4.30	4.15	4.25
16	4.55	4.55	4.20	8.70	8.00	8.20	6.25	4.70	4.25	4.25	4.20	4.20
17	4.55	4.50	4.20	8.50	8.10	8.15	6.10	4.70	4.20	4.25	4.20	4.20
18	4.55	4.50	4.20	8.30	8.30	9.90	6.00	4.70	4.20	4.25	4.25	4.15
19	4.50	4.45	4.20	8.40	8.50	9.40	5.90	4.65	4.20	4.25	4.20	4.10
20	4.30	4.45	4.20	8.40	9.10	9.10	5.90	4.60	4.15	4.25	4.20	4.05
21	4.30	4.45	4.20	8.50	9.80	8.50	5.90	4.60	4.15	4.20	4.25	4.05
22	4.30	4.40	4.20	8.45	10.00	8.20	5.85	4.55	4.20	4.20	4.30	4.05
23	4.45	4.40	4.20	8.40	11.00	7.10	5.85	4.55	4.25	4.20	4.30	4.05
24	4.40	4.40	4.20	8.15	10.50	7.60	5.80	4.50	4.25	4.15	4.30	4.00
25	4.40	4.35	4.20	8.10	9.50	7.40	5.70	4.40	4.20	4.15	4.30	3.90
26	4.40	4.35	4.20	8.05	9.25	7.80	5.60	4.40	4.20	4.15	4.30	3.85
27	4.40	4.35	4.20	8.45	9.00	8.20	5.60	4.40	4.15	4.15	4.25	4.05
28	4.40	4.35	4.20	9.30	9.20	8.50	5.55	4.40	4.15	4.15	4.25	4.10
29	4.40	4.30	4.20	10.00	9.60	8.50	5.50	4.65	4.10	4.15	4.20	4.15
30	4.30	.....	4.20	9.65	9.50	8.50	5.40	4.60	4.10	4.15	4.20	4.15
31	4.30	.....	4.20	.....	9.30	.....	5.35	4.55	.....	4.15	.....	4.15

Rating table for Methow River near Pateros, Wash., from June 17, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.80	345	5.30	1,250	6.80	3,320	8.40	6,420
3.90	365	5.40	1,360	6.90	3,500	8.60	6,840
4.00	390	5.50	1,475	7.00	3,680	8.80	7,260
4.10	420	5.60	1,595	7.10	3,860	9.00	7,680
4.20	460	5.70	1,720	7.20	4,040	9.20	8,100
4.30	505	5.80	1,850	7.30	4,220	9.40	8,520
4.40	555	5.90	1,980	7.40	4,400	9.60	8,940
4.50	605	6.00	2,110	7.50	4,580	9.80	9,360
4.60	665	6.10	2,240	7.60	4,780	10.00	9,780
4.70	725	6.20	2,370	7.70	4,980	10.20	10,200
4.80	790	6.30	2,510	7.80	5,180	10.40	10,620
4.90	865	6.40	2,670	7.90	5,380	10.60	11,040
5.00	950	6.50	2,830	8.00	5,580	10.80	11,460
5.10	1,045	6.60	2,990	8.20	6,000	11.00	11,880
5.20	1,145	6.70	3,150				

The preceding table is applicable only for open-channel conditions. It is based upon 7 discharge measurements made during 1903 and 1904. The table has been extended beyond these limits. Above gage height 8.00 feet the rating curve is a tangent, the difference being 210 per tenth.

Estimated monthly discharge of Methow River near Pateros, Wash., for 1903 and 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
1903.				
June 17-30	13,140	7,260	10,020	278,300
July	6,630	1,746	3,230	198,600
August	1,707	790	1,129	69,420
September	1,045	665	830	49,390
October	1,145	790	984	60,500
November	1,145	769	942	56,050
December	950	665	790	48,580
The period				760,800
1904.				
January	665	505	588	36,160
February	665	505	578	33,250
March	505	460	469	28,840
April	9,780	460	4,101	244,000
May	11,880	4,780	7,018	431,500
June	9,570	3,860	6,945	413,300
July	6,840	1,305	3,353	206,200
August	1,250	555	806	49,560
September	605	420	496	29,510
October	605	420	463	28,470
November	505	440	460	27,370
December	480	355	439	26,990
The year	11,880	355	2,143	1,555,000

CHELAN RIVER BELOW LAKE CHELAN, WASHINGTON.

The Chelan is a short river, being only about 4 miles in length. It connects Lake Chelan with Columbia River, entering the latter at Chelan Falls. It is valuable principally for the water power that can be developed upon it.

A station, to determine the flow from the lake, was established November 6, 1903, by G. H. Bliss. It is located at the highway bridge 3,000 feet below the outlet of the lake and in the town of Chelan. The gage is a vertical rod 16 feet long attached to the third pile bent

of the northwestern approach to the bridge. It is read once each day by G. L. Richardson. Discharge measurements are made from the downstream side of the new highway bridge, to which the gage is attached. The initial point for soundings is the end vertical on the downstream side of the bridge at the northwest approach. The channel is straight for 50 feet above and for 150 feet below the station. The right bank can not overflow. The left bank is lower than the right, but is not liable to overflow. Both banks are without trees. The bed of the stream is composed of rocks and gravel, free from vegetation, and liable to shift somewhat. The bench mark is a wire spike driven into the root of a large cottonwood tree, which is 40 feet downstream from the northwestern approach to the bridge and 30 feet from the river. The root is on the west side of the tree. The elevation of the bench mark is 11.86 feet above the zero of the gage.

A dam which has been constructed at the foot of the lake by the town of Chelan holds back the flow of water from the lake to some extent during the dry season. This dam is about 3,000 feet above the gage board and bridge described above.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Chelan River below Lake Chelan, Washington, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
March 24	G. H. Bliss	249	538	2.11	5.95	1,136
May 21	Steward and Murphy	302	1,331	4.45	9.13	5,926
June 11	W. G. Steward	310	1,664	4.88	10.27	8,122
July 31	do	296	1,092	4.05	8.17	4,421
August 22	do	280	773	3.19	7.15	2,571

Mean daily gage height, in feet, of Chelan River below Lake Chelan, Washington, for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.80	5.60	5.60	5.80	9.00	10.25	10.10	8.30	5.60	5.60	5.40	5.50
2	5.80	5.60	5.55	5.80	9.00	10.30	10.20	8.25	5.40	5.60	5.40	5.50
3	5.75	5.60	5.50	5.75	8.95	10.30	10.30	8.20	5.40	5.60	5.35	5.50
4	5.70	5.55	5.50	5.75	8.90	10.30	10.35	8.15	5.40	5.60	5.40	5.50
5	5.50	5.50	5.50	5.75	8.90	10.35	10.40	8.10	5.45	5.60	5.40	5.50
6	5.60	5.00	5.50	5.75	8.75	10.50	10.50	8.00	6.45	5.60	5.35	5.50
7	5.65	5.45	5.50	5.75	8.65	10.65	10.40	8.00	6.40	5.60	5.35	5.50
8	5.60	5.40	5.55	5.75	8.60	10.60	10.50	7.95	6.45	5.55	5.40	5.50
9	5.70	[a] 5.80	5.55	5.75	8.60	10.50	10.45	7.90	6.40	5.50	5.40	5.45
10	5.70	5.80	5.60	5.75	8.55	10.40	10.55	7.90	6.50	5.50	5.45	5.45
11	5.65	5.75	5.65	5.85	8.50	10.30	10.45	7.80	6.45	5.45	5.45	5.40
12	5.65	5.75	5.60	6.10	8.45	10.20	10.50	7.75	6.40	5.45	5.50	5.40

[a] Opening made in dam.

Mean daily gage height, in feet, of Chelan River below Lake Chelan, Washington, for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
13	5.65	5.70	5.60	6.30	8.40	10.10	10.45	7.70	6.40	5.40	5.50	5.40
14	5.70	5.70	5.60	6.70	8.40	10.00	10.20	7.60	6.40	[a] 5.80	5.45	5.45
15	5.65	5.65	5.60	6.90	8.45	10.05	10.00	7.50	6.40	5.80	5.50	5.50
16	5.60	5.60	5.90	7.20	8.50	10.10	9.80	7.50	6.35	5.80	5.50	5.50
17	5.60	5.60	5.85	7.50	8.60	10.10	9.60	7.40	6.35	5.80	5.50	5.45
18	5.75	5.60	6.20	7.65	8.65	10.30	9.40	7.40	[a] 6.15	5.80	5.45	5.45
19	5.70	5.60	6.20	7.80	8.80	10.40	9.20	7.40	6.15	5.75	5.45	5.45
20	5.60	5.60	6.25	7.90	8.90	10.40	9.10	7.30	6.15	5.75	5.50	5.45
21	5.55	5.60	6.25	8.10	9.00	10.40	8.90	7.20	6.15	5.70	5.50	5.45
22	5.65	5.70	6.15	8.20	9.30	10.35	8.85	7.15	6.10	5.70	5.50	5.45
23	5.60	5.50	6.10	8.25	9.55	10.25	8.85	7.10	6.10	5.70	5.50	5.45
24	5.65	5.50	5.90	8.20	9.80	10.00	8.75	7.05	6.00	5.65	5.50	5.40
25	5.70	5.60	5.90	8.25	9.90	10.00	8.65	7.00	6.05	5.65	5.55	5.40
26	5.70	5.65	5.90	8.30	10.00	9.90	8.20	6.90	6.00	5.60	5.55	5.35
27	5.65	5.70	5.90	8.35	10.00	9.80	8.10	[b] 6.40	5.60	5.55	5.55	5.40
28	5.60	5.65	5.85	8.50	10.00	9.80	8.40	6.00	5.60	5.50	5.50	5.40
29	5.60	5.60	5.80	8.85	10.00	9.90	8.40	5.40	5.60	5.45	5.50	5.35
30	5.60	.....	5.80	8.95	10.10	9.95	8.30	5.50	5.60	5.45	5.50	5.35
31	5.60	.....	5.75	.....	10.15	.....	8.30	5.60	.....	5.40	.....	5.35

[a] Dam partly opened. [b] Dam closed.

Rating table for Chelan River below Lake Chelan, Washington, from November 6, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
5.30	655	6.50	1,650	7.70	3,455	8.90	5,525
5.40	715	6.60	1,770	7.80	3,625	9.00	5,705
5.50	780	6.70	1,900	7.90	3,795	9.20	6,080
5.60	850	6.80	2,040	8.00	3,965	9.40	6,460
5.70	930	6.90	2,190	8.10	4,135	9.60	6,840
5.80	1,010	7.00	2,340	8.20	4,305	9.80	7,220
5.90	1,090	7.10	2,490	8.30	4,475	10.00	7,600
6.00	1,170	7.20	2,640	8.40	4,645	10.20	7,980
6.10	1,255	7.30	2,800	8.50	4,815	10.40	8,360
6.20	1,345	7.40	2,960	8.60	4,985	10.60	8,740
6.30	1,440	7.50	3,120	8.70	5,165	10.80	9,120
6.40	1,540	7.60	3,285	8.80	5,345	11.00	9,500

The above table is applicable only for open-channel conditions. It is based upon 6 discharge measurements made during 1903 and 1904. It is well defined between gage heights 5.90 feet and 10.50 feet. The table has been extended beyond these limits. Above gage height 9.00 feet the rating curve is a tangent, the difference being 190 per tenth.

Estimated monthly discharge of Chelan River below Lake Chelan, Washington, for 1903 and 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
1903.				
November 6-30	1,782	1,300	1,525	90,740
December	2,310	1,010	1,250	76,860
1904.				
January	1,010	780	893	54,910
February	1,010	500	856	49,240
March	1,390	780	997	61,300
April	5,615	970	2,686	159,800
May	7,885	4,545	5,865	360,600
June	8,835	7,220	8,008	476,500
July	8,645	4,135	6,776	416,600
August	4,475	715	2,982	183,400
September	1,650	715	1,235	73,490
October	1,010	715	863	53,060
November	815	685	755	44,930
December	780	685	742	45,620
The year	8,835	500	2,722	1,979,000

WENACHE RIVER AT CASHMERE, WASH.

This station was established July 26, 1904, by W. G. Steward. It is located at the highway bridge just north of the town of Cashmere, Wash. A plain staff gage, graduated to feet and tenths, is nailed vertically to the downstream edge of the south face of the middle pier. It is read once each day by A. C. Jones. Discharge measurements are made from the downstream side of the two-span bridge to which the gage is attached. The initial point for soundings is a bolt head in the southeast corner of the bridge, marked zero. The point is identical with bench mark No. 2. The channel is curved for about 800 feet above and below the station, and the current is swift. The right bank is high, gravelly and rocky, lined with timber and bushes, and not liable to overflow. The left bank is not high, but overflows only in extremely high water. The bed of the stream is covered with small rounded bowlders and cobblestones. It is free from vegetation and permanent. The channel is divided by the pier into two channels. The bridge is located about midway of a long sweeping curve. The water is quite swift, especially at the middle of the south span, which makes sounding at this point difficult, except with heavy weight and small wire.

Bench mark No. 1 is the head of an 8-penny nail driven into a timber at the southeast corner of the middle pier. Its elevation is 12.98 feet above the zero of the gage. Bench mark No. 2 is a bolt head at the southeast corner of the bridge, identical with the initial point. Its elevation is 16.63 feet above the zero of the gage. Bench mark No. 3 is a railroad spike driven into a telephone pole at the left end of the bridge. Its elevation is 10.91 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurement of Wenache River at Cashmere, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
July 26	W. G. Steward	197	1,174	3.22	3.88	3,646

Mean daily gage height, in feet, of Wenache River at Cashmere, Wash., for 1904.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		3.40	2.20	1.70	1.20	2.30
2		3.40	2.10	1.70	1.30	2.30
3		3.40	2.00	1.60	1.30	2.20
4		3.30	2.00	1.60	1.30	2.10
5		3.30	2.00	1.50	1.30	2.00
6		3.20	1.90	1.40	1.30	1.90
7		3.20	1.90	1.40	1.30	1.90
8		3.20	1.90	1.30	1.10	1.80
9		3.20	2.00	1.30	1.20	1.80
10		3.10	2.00	1.20	1.30	1.80
11		2.90	1.90	1.80	1.30	1.80
12		2.70	1.90	2.00	1.30	1.70
13		2.60	1.90	1.80	1.30	1.70
14		2.60	1.70	1.60	1.30	1.80
15		2.60	1.70	1.50	1.30	2.10
16		2.60	1.60	1.40	1.40	2.20
17		2.50	1.60	1.40	2.00	2.20
18		2.50	1.60	1.40	1.80	2.30
19		2.40	1.60	1.30	1.80	2.20
20		2.40	1.60	1.30	1.90	2.30
21		2.30	1.50	1.30	2.20	2.30
22		2.20	1.50	1.40	2.40	2.20
23		2.10	1.60	1.30	2.60	2.20
24		2.05	1.60	1.30	2.40	2.10
25		2.00	1.50	1.20	2.20	1.90
26		2.00	1.50	1.20	2.10	1.90
27	3.90	2.00	1.50	1.20	2.10	1.80
28	3.90	2.00	1.40	1.20	2.20	1.80
29	3.70	2.40	1.40	1.20	2.50	1.80
30	3.50	2.40	1.60	1.20	2.40	1.80
31	3.40	2.30	.....	1.20	.....	1.80

CRAB CREEK AT WILSON CREEK, WASH.

This station was established March 18, 1904, by Charles E. Hewitt. It is located at a wagon bridge one-fourth mile west of the Great Northern Railroad depot at Wilson Creek, Wash., and 300 feet south of the railroad. Discharge measurements are made from the upstream side of the bridge. The gage is a 6-inch board 13 feet long, graduated to feet and half tenths, and attached to the west end of the first pier from the north end of the bridge. The initial point for sounding is a nail in a 2 by 4 inch stake 94 feet south of the face of the south abutment of the bridge and 5 feet east of the road. The channel is straight for one-fourth mile above and 50 feet below the station. The right bank is low and overflows at extreme high water. The left bank is high and not liable to overflow. The bed of the stream is mud and gravel and is fairly permanent. The current is swift. The stream is divided into five channels at high water and two channels at ordinary stages. The bench mark is the top of a stone 5 feet east of the road and 13 feet south of the initial point. Its elevation is 18.22 feet above gage datum. This station was abandoned June 26, 1904.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Crab Creek at Wilson Creek, Washington, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
March 18	C. E. Hewett	81	308	2.55	4.86	785
April 29	W. G. Steward	50	196	1.14	3.95	223
June 16	do		266	1.32	3.77	345

Mean daily gage height, in feet, of Crab Creek at Wilson Creek, Washington, for 1904.

Day.	March.	April.	May.	June.	Day.	March.	April.	May.	June.
1		4.70	4.20	3.00	17		4.25	3.80	3.75
2		5.05	4.20	4.35	18		4.25	3.75	3.70
3		4.80	4.60	4.30	19	5.00	4.25	3.75	3.80
4		4.85	4.60	4.25	20	4.97	4.20	3.70	3.70
5		4.89	4.60	3.00	21	4.95	4.21	3.70	3.70
6		5.00	4.60	3.00	22	4.90	4.20	3.70	3.65
7		4.95	4.60	3.95	23	4.86	4.21	3.00	3.65
8		4.85	4.60	3.90	24	4.86	5.20	3.55	3.60
9		4.70	4.60	3.85	25	4.85	5.15	3.55	3.55
10		4.55	4.50	3.80	26	4.83	5.15	3.55	
11		4.57	4.20	3.75	27	4.70	4.00	3.50	
12		4.45	4.15	3.80	28	4.65	5.10	3.50	
13		4.40	4.10	3.75	29	4.60	4.00	3.35	
14		4.35	4.05	3.75	30	4.80	4.00	3.35	
15		4.30	3.00	3.70	31	4.74		3.30	
16		4.24	3.85	3.75					

YAKIMA RIVER NEAR MARTIN, WASH.

Lake Keechelus is the uppermost of the three lakes forming the source of Yakima River. At the mouth a good dam site exists and by the construction of a dam a considerable portion of the flow of the Yakima, at this point, can be stored and used for irrigation in the lower Yakima Valley during the dry season.

A gaging station was established October 18, 1903, by G. H. Bliss, 1,000 feet below the outlet of Lake Keechelus and 800 feet below the dam of the Cascade Lumber Company. It is 4 miles northwest of Martin, Wash. The original gage was in two sections and was located on the right bank just above the cable. The lower inclined section read from 5 to 7 feet. The upper vertical section read from 7 to 13 feet. Observations were taken daily from this gage until November 14, 1903, on which date the gage was destroyed by the caving of the river bank. Observations were then discontinued until January 28, 1904, when a new vertical gage, No. 2, was installed by the Yakima Development Company, at a point 75 feet above the location of the old gage, and readings were resumed by the United States Geological Survey. This gage is in present use. It is a vertical rod, fastened to an overhanging tree, and is divided into feet and tenths. The gage is read daily by Christian Hansen, a trapper, living at the foot of the lake. Discharge measurements are made by means of a cable, car, tagged wire, and stay wire. The cable has a total span of 200 feet. The initial point for soundings is the north face of the tree on the south, or right, bank, to which the cable is fastened. The channel is straight for 500 feet above and for 350 feet below the station. Both banks are high, not liable to overflow, and are heavily timbered. The current is swift. There is but one channel at all stages. The bed of the stream is composed of gravel, free from vegetation, and permanent.

Bench mark No. 1 was destroyed with the original gage. Bench mark No. 2 is the top of a spike in the root on the north side of a large cedar tree 50 feet south and 50 feet west of the gage. Its elevation is 21.59 feet above the zero of gage No. 2. Bench mark No. 3 is a nail in the base of a 48-inch fir tree on the right bank, 25 feet above the cable, and 50 feet from the river. The tree is blazed and marked "B. M." The elevation of the bench mark is 25.22 feet above the datum of gage No. 2 which is 0.07 foot higher than that of gage No. 1.

The observations at this station during 1904 were made under the direction of T. A. Noble, district engineer.

Discharge measurements of Yakima River near Martin, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 13	G. F. Harley	117	288	1.90	8.15	543
June 15	do	119	365	2.27	8.88	827
July 21	do	116	208	1.17	7.25	244
August 4	do	106	175	.77	6.88	135
September 20	do	104	122	.48	6.34	58

Mean daily gage height, in feet, of Yakima River near Martin, Wash., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	7.10	6.90	6.90	8.65	8.90	8.40	6.90	6.50	6.40	6.50	8.00
2	.....	7.00	6.90	6.90	8.45	9.00	8.40	6.90	6.50	6.40	6.50	7.90
3	.....	7.00	6.80	6.80	8.35	9.10	8.30	6.90	6.50	6.40	6.50	7.70
4	.....	7.00	6.80	6.80	8.25	9.30	8.20	6.90	6.40	6.40	6.50	7.60
5	.....	7.00	6.90	6.90	8.15	9.40	8.20	6.80	6.40	6.40	6.50	7.50
6	.....	7.00	6.90	6.90	8.10	9.40	8.20	6.80	6.40	6.40	6.50	7.40
7	.....	7.00	6.90	6.90	8.10	9.40	8.10	6.80	6.40	6.30	6.50	7.30
8	.....	7.00	6.95	6.90	8.05	9.20	8.00	6.80	6.40	6.40	6.50	7.20
9	.....	6.95	7.00	6.90	8.00	8.80	7.90	6.80	6.40	6.40	6.50	7.20
10	.....	6.90	7.05	7.00	8.00	8.80	7.80	6.70	6.40	6.40	6.50	7.10
11	.....	6.90	7.10	7.15	7.90	8.70	7.75	6.70	6.40	6.40	6.50	7.10
12	.....	6.90	7.10	7.55	8.20	8.55	7.70	6.70	6.40	6.40	6.50	7.10
13	.....	6.90	7.10	8.10	8.20	8.60	7.60	6.65	6.40	6.40	6.50	7.10
14	.....	6.90	7.10	8.60	8.70	8.70	7.45	6.60	6.40	6.40	6.50	7.20
15	.....	6.90	7.10	9.00	8.60	8.80	7.40	6.60	6.40	6.40	6.50	7.40
16	.....	6.90	7.05	9.00	8.60	8.90	7.30	6.60	6.40	6.50	6.60	7.60
17	.....	6.90	7.00	8.80	8.55	8.80	7.30	6.60	6.40	6.50	6.75	8.00
18	.....	6.85	7.00	8.65	8.55	9.00	7.30	6.60	6.40	6.50	6.80	8.10
19	.....	6.80	7.00	8.60	8.70	9.10	7.30	6.60	6.30	6.50	6.95	8.20
20	.....	6.80	7.00	8.60	8.80	8.85	7.30	6.60	6.30	6.50	7.30	8.30
21	.....	6.90	7.00	8.65	8.95	8.75	7.20	6.50	6.30	6.50	7.85	8.15
22	.....	6.90	6.90	8.60	9.20	8.60	7.25	6.50	6.30	6.50	8.15	8.00
23	.....	7.00	6.90	8.50	9.40	8.45	7.20	6.50	6.30	6.50	8.20	7.90
24	.....	7.00	6.90	8.30	9.30	8.25	7.10	6.50	6.30	6.50	8.00	7.75
25	.....	6.90	6.90	8.15	9.10	8.20	7.10	6.50	6.30	6.50	7.90	7.60
26	.....	6.90	6.80	8.15	9.00	8.10	7.10	6.50	6.30	6.50	7.90	7.50
27	.....	6.25	6.80	8.35	9.00	8.20	7.00	6.50	6.30	6.50	7.85	7.40
28	7.20	6.90	6.80	8.70	9.00	8.20	7.00	6.50	6.30	6.50	8.10	7.30
29	7.20	6.90	6.90	9.00	9.10	8.30	7.00	6.50	6.40	6.50	8.10	7.20
30	7.10	.....	6.90	8.95	9.10	8.40	7.00	6.50	6.40	6.40	8.00	7.20
31	7.10	.....	6.90	.....	9.10	.....	6.90	6.50	.....	6.50	.....	7.20

Rating table for Yakima River, near Martin, Wash., from January 28 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
6.30	51	7.30	249	8.20	566	9.10	920
6.40	63	7.40	281	8.30	604	9.20	960
6.50	76	7.50	315	8.40	642	9.30	1,000
6.60	90	7.60	349	8.50	680	9.40	1,040
6.70	107	7.70	383	8.60	720	9.50	1,080
6.80	127	7.80	418	8.70	760	9.60	1,120
6.90	148	7.90	454	8.80	800	9.70	1,160
7.00	170	8.00	490	8.90	840	9.80	1,200
7.10	194	8.10	528	9.00	880	9.90	1,240
7.20	220						

The above table is applicable only for open-channel conditions. It is based upon 5 discharge measurements made during 1904. It is well defined between gage heights 6.36 feet and 8.88 feet. The table has been extended beyond these limits. Above gage height 8.50 feet the rating curve is a tangent, the difference being 40 per tenth.

Estimated monthly discharge of Yakima River near Martin, Wash., for 1904.

[Drainage area, 56 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Second-feet per square mile.	Depth in inches.
	Maximum.	Minimum.	Mean.			
February	194	127	156	8,973	2.79	3.01
March	194	127	159	9,777	2.84	3.27
April	880	127	499	29,690	8.91	9.94
May	1,040	454	733	45,070	13.1	15.1
June	1,040	528	785	46,710	14.0	15.6
July	642	148	339	20,840	6.05	6.98
August	148	76	103	6,333	1.84	2.12
September	76	51	58.6	3,487	1.05	1.17
October	76	51	69.4	4,243	1.24	1.43
November	566	76	230	13,680	4.11	4.59
December	604	194	339	20,840	6.05	6.98
The period				209,600		

YAKIMA RIVER AT EASTON, WASH.

This station was established May 12, 1904, by G. H. Bliss. It is located at Easton, Wash., three-eighths of a mile below the Cascade Lumber Company's dam, at the bridge on the road leading from

Easton to Kachess Lake. A vertical staff gage, graduated to feet and tenths, is nailed to a stump on the left bank, 20 feet below the bridge. It is read once each day by W. W. Johnson. Discharge measurements are made from the downstream side of the highway bridge. The initial point for soundings is a point marked by a circle and cross on the top of the downstream railing 12 feet north of the pier on the left bank. The channel is straight for about 400 feet above and 700 feet below the station, and the water is swift at medium and high stages. The right bank is high, sparsely wooded, and not liable to overflow. The left bank is low, sparsely wooded, and overflows only at extreme high water. The bed of the stream is composed of clean gravel, and is shifting. There is but one channel, which is broken at higher stages by the piling supports of the trestle approaches at either end. There is a shifting gravel bar on the right side of the channel. Diagonal currents interfere with the accuracy of measurements. The bench mark is the top of the case of the steel and concrete pier at the left end on the downstream side of the bridge. Its elevation is 19.39 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Yakima River at Easton, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 12	G. F. Harley	148	384	3.70	6.95	1,417
June 14	do	173	428	4.36	7.35	1,868
July 12	do	140	219	3.27	5.74	717
July 21	do	136	169	2.98	5.06	502
August 4	do	125	119	2.79	4.45	332
August 24	do	122	80	2.33	3.86	186

Mean daily gage height, in feet, of Yakima River at Easton, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1		7.75	6.40	4.70	4.40	4.20	3.90
2		8.00	6.30	4.60	4.40	4.40	3.90
3		7.90	6.40	4.50	4.40	4.30	3.90
4		7.90	6.70	4.80	4.35	4.40	3.90
5		8.05	6.70	4.50	4.40	4.30	3.80
6		8.10	6.60	4.50	4.40	4.25	3.80
7		7.90	6.50	4.50	4.40	4.25	3.80
8		7.70	6.30	4.30	4.40	4.25	3.80
9		7.60	5.90	4.50	4.40	4.25	3.80
10		7.50	5.80	4.30	4.40	4.30	3.80
11		7.60	5.80	4.50	4.40	4.30	3.80
12	6.95	7.25	5.70	4.50	4.45	4.20	3.90

Mean daily gage height, in feet, of Yakima River at Easton, Wash., for 1904—Continued.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
13	7.00	7.10	5.60	4.50	4.30	4.20	3.90
14	7.40	7.50	5.40	4.50	4.30	4.20	3.90
15	7.50	7.30	5.50	4.50	4.40	4.20	3.80
16	7.40	7.30	5.30	4.40	4.35	4.20	3.80
17	7.10	7.25	5.40	4.40	4.30	4.20	3.90
18	6.70	7.70	5.30	4.00	4.40	4.20	3.95
19	6.70	7.35	5.20	4.00	4.30	4.10	4.10
20	6.70	7.60	5.20	4.00	3.80	4.10	4.55
21	7.20	7.50	5.20	4.00	3.90	4.00	5.30
22	7.70	7.10	5.00	4.20	4.40	4.20	5.80
23	8.00	6.90	5.00	4.30	4.40	4.00	5.90
24	7.90	6.70	4.90	3.85	4.40	3.90	5.90
25	7.50	6.50	4.90	4.20	4.40	3.95	5.80
26	7.70	6.30	4.90	4.30	4.40	4.00	5.80
27	7.70	6.40	4.90	4.40	4.40	4.00	5.80
28	7.80	6.20	4.80	4.40	4.40	3.90	6.20
29	7.70	6.20	4.90	4.50	4.40	3.90	(a)
30	7.80	6.20	4.70	4.40	4.40	3.90	.....
31	7.80	.....	4.70	4.40	.....	3.90	.....

a Gage washed out.

Rating table for Yakima River at Easton, Wash., from May 12 to November 28, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.90	195	5.00	484	6.00	814	7.00	1,490
4.00	220	5.10	512	6.10	862	7.10	1,590
4.10	246	5.20	540	6.20	910	7.20	1,695
4.20	272	5.30	572	6.30	966	7.30	1,805
4.30	298	5.40	604	6.40	1,022	7.40	1,920
4.40	324	5.50	636	6.50	1,086	7.50	2,040
4.50	350	5.60	668	6.60	1,154	7.60	2,160
4.60	376	5.70	700	6.70	1,230	7.70	2,290
4.70	402	5.80	736	6.80	1,310	7.80	2,420
4.80	428	5.90	774	6.90	1,395	7.90	2,550
4.90	456						

The above table is applicable only for open-channel conditions. It is based upon 6 discharge measurements made during 1904. It is well defined between gage heights 3.86 feet and 7.35 feet. The table has been extended beyond these limits. Above gage height 7.60 feet the rating curve is a tangent, the difference being 130 per tenth.

Estimated monthly discharge of Yakima River at Easton, Wash., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
May 12–31	2,680	1,230	1,974	78,310
June	2,810	910	1,867	111,100
July	1,230	402	690	42,430
August	428	185	316	19,430
September	337	175	311	18,510
October	324	195	257	15,800
November 1–28	910	175	357	19,830
The period				305,400

YAKIMA RIVER NEAR NORTH YAKIMA, WASH.

This station was established May 5, 1904, by G. H. Bliss. It is located at the highway bridge, 2¼ miles north of North Yakima, Wash., one-fourth mile above the confluence of Yakima and Naches rivers, and 300 feet east of the bridge of the Northern Pacific Railway Company. A plain staff gage is fastened vertically to the south side of the pier at the right end of the 4-span highway bridge. The gage is read once each day by Patrick Gallagher. Discharge measurements are made from the downstream side of the bridge to which the gage is attached. The initial point for soundings is a point marked zero on the top of railing near the right end of the bridge, downstream side. The channel is straight for about 800 feet above and 600 feet below the station. The current is sluggish at low stages. Both banks are low, partly wooded, and subject to overflow during high water. The bed of the stream is composed of gravel and sand, free from vegetation and stable. There is one channel at all stages, broken by 3 bridge piers. The bench mark is the top of the shoe plate on the lower side of the bridge above the pier nearest the right bank. Its elevation is 16.64 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Yakima River near North Yakima, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 5	G. F. Harley	217	1,600	4.21	6.83	6,740
July 13	do	201	1,090	2.39	4.40	2,610
July 25	J. C. Dry	188	850	1.60	3.30	1,360
July 30	G. F. Harley	187	830	1.35	3.10	1,123
August 17	J. C. Dry	156	727	0.77	2.40	556
September 1	do	156	725	0.61	2.32	444

Mean daily gage height, in feet, of Yakima River near North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	7.20	5.20	3.10	2.30	2.40	2.40
2	.....	7.00	5.20	3.00	2.30	2.40	2.40
3	.....	7.00	.....	3.00	2.30	2.40	2.40
4	.....	7.10	5.30	3.00	.....	2.40	2.40
5	.....	.....	5.40	2.90	2.30	2.50	2.40
6	.....	7.50	5.30	2.90	2.30	2.50	.....
7	.....	7.60	5.20	.....	2.20	2.50	2.40
8	.....	7.10	5.10	2.80	2.20	2.50	2.40
9	6.00	6.70	5.00	2.70	2.20	2.50	2.40
10	5.90	6.30	.....	2.70	2.20	2.50	2.40
11	5.80	6.90	4.70	2.60	.....	2.50	2.40
12	5.80	.....	4.50	2.60	2.20	2.60	2.40
13	5.90	5.70	4.40	2.60	2.20	2.60	.....
14	6.30	5.70	4.30	2.60	2.20	2.60	2.40
15	.....	5.90	4.20	2.50	2.20	2.60	2.40
16	6.80	6.10	4.10	2.50	2.10	2.60	2.40
17	6.80	6.30	.....	2.50	2.10	2.60	2.40
18	6.80	6.50	3.80	2.40	.....	2.60	2.40
19	6.90	.....	3.70	2.40	2.10	2.60	2.40
20	6.90	6.40	3.60	2.40	2.10	2.60	.....
21	7.10	6.30	3.50	.....	2.10	2.50	2.90
22	.....	6.10	3.40	2.30	2.10	2.50	3.90
23	8.10	5.90	3.40	2.30	2.10	.....	3.60
24	8.40	5.60	.....	2.30	2.10	2.50	3.90
25	7.90	5.30	3.30	2.30	.....	2.50	3.70
26	7.50	.....	3.30	2.30	2.30	2.50	3.70
27	7.20	5.20	3.30	2.30	2.30	2.50	.....
28	7.10	5.10	3.20	.....	2.40	2.40	3.80
29	.....	5.00	3.20	2.30	2.40	2.40	3.80
30	7.30	5.10	3.10	2.30	2.40	.....	4.00
31	7.30	.....	.....	2.30	.....	2.40	.....

NOTE.—Observations were made during irrigating season only.

Rating table for Yakima River near North Yakima, Wash., from May 9 to November 30, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.00	210	3.30	1,342	4.60	2,916	5.90	5,004
2.10	285	3.40	1,445	4.70	3,059	6.00	5,190
2.20	362	3.50	1,550	4.80	3,204	6.20	5,562
2.30	441	3.60	1,658	4.90	3,351	6.40	5,934
2.40	522	3.70	1,769	5.00	3,500	6.60	6,306
2.50	605	3.80	1,883	5.10	3,651	6.80	6,678
2.60	690	3.90	2,000	5.20	3,805	7.00	7,050
2.70	777	4.00	2,120	5.30	3,962	7.20	7,422
2.80	866	4.10	2,243	5.40	4,124	7.40	7,794
2.90	957	4.20	2,370	5.50	4,290	7.60	8,166
3.00	1,050	4.30	2,501	5.60	4,461	7.80	8,538
3.10	1,145	4.40	2,636	5.70	4,637	8.00	8,910
3.20	1,242	4.50	2,775	5.80	4,818	8.50	9,840

The above table is applicable only for open-channel conditions. It is based upon 6 discharge measurements made during 1904. It is well defined between gage heights 2.50 feet and 4.50 feet. The table has been extended beyond these limits. Above gage height 5.80 feet the rating curve is a tangent, the difference being 186 per tenth.

Estimated monthly discharge of Yakima River near North Yakima, Wash., for 1904.[a]

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
May 9–31	9,654	4,818	6,896	314,600
June	8,166	3,500	5,705	339,500
July	4,124	1,145	2,431	149,500
August	1,145	441	663	40,770
September	522	285	376	22,370
October	690	522	608	37,380
November	2,120	522	955	56,830
The period				961,000

[a] Discharge for missing gage heights interpolated.

YAKIMA RIVER NEAR YAKIMA, WASH.

Yakima River enters Columbia River just above the town of Pasco. The first measurement of the river was made at this point on August 14, 1893. At that time there was an old vertical river rod attached to

the central pier of the bridge. As the foot of this gage at low water was covered by rock and could not be read, an inclined gage was put in position at the west end of the county bridge. This consisted of two pieces of timber, having a total length of 24 feet. These were firmly secured to timbers, bedded, and loaded with rock. The gage rod was painted white and lettered in vertical feet and tenths. After this new gage was located it was ascertained that the readings on the old gage would be 1.13 feet higher than on the new. The zero of this new gage was 19.02 feet below the top of the rail of the Northern Pacific Railroad immediately west of the west end of the bridge, which was about 40 feet from the gage. The high-water mark at that time showed that a flood had risen to 8.80 feet on the old gage. Readings at this point were begun on October 2, 1893, and continued during the following winter and spring until May 19, 1894. Owing to the destruction of the gage by floods the station was for a time abandoned.

During August, 1895, Arthur P. Davis visited the locality and found that the section was not favorable for making discharge measurements. He accordingly selected the present station, which is located at Union Gap, 2 miles below Yakima, Wash., and 1,000 feet below the highway bridge. It is about 3 miles above the intake of the Sunnyside canal. The station is of value, as it is the only point near the large irrigated area above and below which is unaffected by the taking out of water in irrigating canals. The gage rod is inclined and is attached to a willow stump and post set in the ground. It is read once each day by Hugh Kennedy, the section foreman. Discharge measurements are made by means of a cable, car, and tagged wire 150 feet above the gage and 1,000 feet below the highway bridge. The initial point for soundings is a cross chiseled on a rock 2.7 feet from the cable support on the right bank. The channel is straight for 1,000 feet above and below the station. The current has a moderate velocity. The right bank is high, not liable to overflow, and is covered with sagebrush. The left bank is a low gravel bar which overflows during extreme high water. The bed of the stream is composed of gravel, free from vegetation and permanent. There is one channel at low water and two channels at ordinary and flood stages. Bench mark No. 1 is the top of a large bowlder between two other bowlders 43 feet north of the gage and 6.5 feet east of the fence. Its elevation is 17.52 feet above the zero of the gage. Bench mark No. 2 is the top of a large bowlder under the railroad fence 12 feet north of the gage. Its elevation is 21.29 feet above the zero of the gage. The elevation of the initial point for soundings is 17.45 feet above the zero of the gage. The bench marks are marked "B. M." with black paint.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Yakima River near Yakima, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec. feet.*
May 9	G. F. Harley	343	2,140	4.29	7.85	9,180
May 16	do	353	2,530	5.33	8.85	13,490
May 19	Murphy and Bliss	349	2,570	5.48	8.87	14,080
May 24	G. F. Harley	468	3,310	6.40	10.40	21,180
May 25	do	457	3,050	6.07	10.00	18,560
June 29	do	337	1,850	4.17	7.40	7,750
July 18	do	241	1,340	2.51	5.78	3,370
July 23	do	239	1,273	2.26	5.48	2,873
August 1	do	237	1,131	1.78	4.87	2,015
August 25	do	234	865	1.05	3.79	910

Mean daily gage height, in feet, of Yakima River near Yakima, Wash., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.50	5.50	4.90	5.70	10.20	9.40	7.60	4.90	3.80	3.90	3.80	6.00
2	5.50	5.50	4.90	5.90	9.70	9.20	7.60	4.90	3.80	3.90	3.80	5.90
3	5.30	5.40	4.90	6.50	9.40	9.50	7.40	4.80	3.80	3.90	3.80	5.90
4	5.30	5.40	4.90	7.20	9.30	9.00	7.40	4.80	3.80	3.90	3.80	5.60
5	5.30	5.40	4.80	7.10	9.00	9.10	7.60	4.70	3.80	3.90	3.80	5.40
6	5.00	5.30	5.20	7.80	8.90	9.40	7.60	4.70	3.75	3.90	3.80	5.40
7	5.10	5.30	5.60	7.50	8.60	9.40	7.60	4.60	3.70	3.90	3.80	5.30
8	5.20	5.30	7.30	7.30	8.00	9.00	7.40	4.50	3.70	3.90	3.90	5.20
9	5.20	5.30	6.10	7.50	7.80	8.60	7.30	4.50	3.70	3.90	3.90	5.20
10	5.20	5.10	6.10	8.70	7.80	8.40	7.00	4.30	3.70	3.90	3.90	5.00
11	5.30	5.10	6.80	9.30	7.90	8.00	6.90	4.30	3.70	4.00	3.90	5.00
12	5.40	5.00	6.40	10.10	8.00	7.90	6.90	4.20	3.70	4.00	3.90	5.00
13	5.40	4.90	6.30	10.80	8.00	7.60	6.70	4.20	3.70	4.00	3.90	4.90
14	5.90	5.00	6.10	11.50	8.40	7.70	6.30	4.10	3.70	4.10	3.90	4.90
15	6.00	5.10	6.00	12.20	8.60	8.00	6.10	4.10	3.70	4.10	3.90	5.00
16	6.70	5.10	6.00	12.10	8.60	8.30	6.00	4.10	3.70	4.00	3.85	5.40
17	6.70	5.00	5.90	11.50	8.80	8.50	6.00	4.00	3.65	4.00	3.85	5.50
18	6.50	5.00	5.70	10.70	8.80	8.70	5.90	4.00	3.65	4.00	4.00	5.50
19	6.50	5.00	5.70	10.50	8.90	8.60	5.90	4.00	3.65	4.00	4.00	5.50
20	6.30	5.00	5.80	10.50	9.00	8.40	5.80	3.9	3.65	4.00	4.10	5.60
21	6.30	5.00	5.80	11.30	9.20	8.30	5.70	3.90	3.65	4.00	5.80	5.70
22	6.10	5.00	5.90	10.50	10.00	8.20	5.60	3.90	3.65	4.00	6.30	5.80
23	6.10	5.40	5.70	10.50	10.60	8.20	5.60	3.80	3.70	3.90	6.30	5.80
24	6.00	5.20	5.70	9.70	10.50	8.00	5.50	3.80	3.80	3.90	6.30	5.80
25	6.00	5.20	5.60	9.40	10.50	7.80	5.50	3.80	3.80	3.90	6.20	5.60
26	5.90	5.20	5.60	9.70	9.05	7.60	5.30	3.80	3.80	3.90	6.00	5.50
27	5.90	5.30	5.60	10.20	9.10	7.20	5.20	3.80	3.80	3.90	6.20	5.30
28	5.80	5.10	6.40	10.50	9.00	7.20	5.20	3.85	3.85	3.90	6.20	5.20
29	5.60	5.00	5.40	11.00	9.40	7.30	5.00	3.85	3.85	3.90	6.30	5.20
30	5.60	.....	5.60	10.90	9.40	7.60	5.00	3.80	3.80	3.80	6.30	5.10
31	5.50	.....	5.70	.....	9.50	.....	5.00	3.80	.....	3.80	.....	5.10

Rating table for Yakima River near Yakima, Wash., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.70	840	5.10	2,315	6.40	4,775	8.40	11,600
3.80	920	5.20	2,455	6.50	5,035	8.60	12,480
3.90	1,000	5.30	2,600	6.60	5,295	8.80	13,360
4.00	1,090	5.40	2,750	6.70	5,565	9.00	14,240
4.10	1,180	5.50	2,910	6.80	5,835	9.20	15,120
4.20	1,280	5.60	3,070	6.90	6,115	9.40	16,000
4.30	1,380	5.70	3,240	7.00	6,405	9.60	16,880
4.40	1,480	5.80	3,420	7.20	7,025	9.80	17,760
4.50	1,580	5.90	3,615	7.40	7,720	10.00	18,640
4.60	1,690	6.00	3,830	7.60	8,440	10.50	20,840
4.70	1,800	6.10	4,055	7.80	9,170	11.00	23,040
4.80	1,920	6.20	4,285	8.00	9,930	11.50	25,240
4.90	2,045	6.30	4,525	8.20	10,740	12.00	27,440
5.00	2,180						

The above table is applicable only for open-channel conditions. It is based upon 10 discharge measurements made during 1904. It is fairly well defined between gage heights 3.80 and 10.00. The table has been extended beyond these limits. Above gage height 8.30 feet the rating curve is a tangent, the difference being 440 per tenth.

Estimated monthly discharge of Yakima River near Yakima, Wash., for 1904.

[Drainage area, 3,300 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	5,570	2,180	3,482	214,800	1.06	1.22
February	2,910	2,050	2,430	139,800	.736	.794
March	7,360	1,920	3,487	214,400	1.06	1.22
April	29,320	3,240	16,730	995,300	5.07	5.66
May	21,280	9,170	14,400	885,500	4.36	5.03
June	16,440	7,030	11,460	681,100	3.47	3.87
July	8,440	2,180	4,939	303,700	1.50	1.73
August	2,050	920	1,287	79,130	.390	.450
September	960	800	868	51,650	.263	.293
October	1,180	920	1,036	63,700	.314	.362
November	4,525	920	2,082	123,900	.631	.704
December	3,830	2,045	2,778	170,800	.842	.971
The year	29,320	800	5,415	3,924,000	1.64	22.30

YAKIMA RIVER AT PROSSER, WASH.

This station was established May 30, 1904, by G. H. Bliss. It is located at the highway bridge 600 feet below Prosser Falls at Prosser, Wash. A standard chain gage is attached to the upstream side of the bridge near the right bank. The length of the chain from the end of the weight to the marker is 28.06 feet. This length is marked on the upstream guard rail by means of two nails. The gage is read twice each day by J. N. Jacoby and Bernard Winter. Discharge measurements are made from the downstream side of the bridge to which the gage is attached. The bridge has a single span with trestle approach at either end. The initial point for soundings is a nail driven into the downstream guard rail 30 feet from the right bank. The channel is straight for about 100 feet above and 600 feet below the station. The current above the station is swift, the foot of the rapids being 150 feet above. The current below the station is sluggish at ordinary and swift at higher stages. Both banks are high and not subject to overflow. The bed of the stream is composed of rock, free from vegetation, and permanent. There are large bowlders in the channel. There is but one channel at all stages, broken by the trestle bents on either side during the higher stages. Bench mark No. 1 is a spike in a sill on the east end of the pump house of the Prosser Irrigation Company's canal. Its elevation is 13.870 feet above the datum of the gage. Bench mark No. 2 is a spike on upright bridge timber 20 feet south of the steel and concrete pier on the south bank. Its elevation is 11.422 feet above the datum of the gage. Bench mark No. 3 is the top of the steel cylinder of the concrete pier at the right bank, upstream side. Its elevation is 23.923 feet above the datum of the gage.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Yakima River at Prosser, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 30	G. F. Harley	228	2,500	5.90	10.08	[a] 14,800
July 26	do	151	1,340	1.51	4.00	2,030
August 11	do	136	1,020	.70	2.30	705
September 17	G. H. Bliss				.90	[b] 258

[a] Surface measurement.

[b] Flume, 175; river, 90; pump 7.

Mean daily gage height, in feet, of Yakima River at Prosser, Wash., for 1904.

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	June.	July.	Aug.	Sept.	Oct.
1	10.04	7.50	3.46	1.08	1.58	17	8.75	5.58	1.87	.83	.....
2	.....	7.87	3.42	1.12	1.50	18	9.00	5.37	1.75	.83	.....
3	.....	8.08	3.33	1.17	1.75	19	9.37	4.75	1.67	.92	.....
4	9.62	8.29	3.25	1.04	1.75	20	9.33	4.71	1.50	.96	.....
5	9.75	8.37	3.12	1.12	1.75	21	9.04	4.54	1.42	.96	.....
6	10.00	8.31	2.92	1.17	1.75	22	8.71	4.50	1.33	.96	.....
7	10.21	8.08	2.75	1.12	1.75	23	8.54	4.37	1.29	1.00	.....
8	10.10	8.00	2.67	1.00	1.83	24	8.12	4.21	1.29	1.04	.....
9	9.50	7.50	2.54	.87	1.83	25	7.67	4.08	1.25	1.17	.....
10	9.04	7.25	2.42	.79	1.83	26	7.33	4.04	1.29	1.23	.....
11	8.79	7.08	2.33	.75	.....	27	7.17	3.87	1.21	1.42	.....
12	8.50	6.92	2.25	.83	.....	28	7.21	3.79	1.21	1.42	.....
13	8.23	6.67	2.12	.83	.....	29	7.37	3.75	1.17	1.42	.....
14	8.04	6.33	2.08	.83	.....	30	7.50	3.67	1.17	1.50	.....
15	8.19	6.08	2.00	.83	.....	31	.....	3.62	1.08	.....	.....
16	8.50	5.83	1.96	.92	.....						

Rating table for Yakima River at Prosser, Wash., from May 29 to October 10, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.80	252	2.40	766	3.90	1,920	5.80	4,800
.90	260	2.50	820	4.00	2,030	6.00	5,200
1.00	270	2.60	877	4.10	2,140	6.20	5,600
1.10	283	2.70	936	4.20	2,250	6.40	6,020
1.20	300	2.80	998	4.30	2,360	6.60	6,460
1.30	321	2.90	1,063	4.40	2,470	6.80	6,940
1.40	346	3.00	1,132	4.50	2,595	7.00	7,420
1.50	375	3.10	1,204	4.60	2,725	7.50	8,620
1.60	408	3.20	1,279	4.70	2,860	8.00	9,820
1.70	445	3.30	1,358	4.80	3,000	8.50	11,020
1.80	485	3.40	1,439	4.90	3,150	9.00	12,220
1.90	527	3.50	1,523	5.00	3,310	9.50	13,420
2.00	570	3.60	1,610	5.20	3,660	10.00	14,620
2.10	616	3.70	1,705	5.40	4,020	10.50	15,820
2.20	664	3.80	1,810	5.60	4,400	11.00	17,020
2.30	714						

The above table is applicable only for open-channel conditions. It is well defined to gage height 10.08 feet. The table has been extended above this limit. Above gage height 6.60 feet the rating curve is a tangent, the difference being 240 per tenth.

Estimated monthly discharge of Yakima River at Prosser, Wash., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April[a]			16,670	957,000
May[a]			13,810	849,400
June[b]	15,100	7,780	11,500	695,000
July	10,660	1,610	5,512	338,900
August	1,480	280	658	40,460
September	375	250	282	16,780
October 1-10			457	9,243
The period				2,907,000

[a] Estimated from discharge at Union Gap. [b] Discharge estimated for June 2 and 3.

NOTE.—The discharges given above are those which occur below the wasteway of flume of Prosser Falls power house Flume waste = 200 second-feet

YAKIMA RIVER AT KIONA, WASH.

This station was established August 20, 1895. It is located at the highway bridge on the county road about 1,800 feet northwest of the Northern Pacific Railroad station at Kiona, Wash. It is about 23 miles above the mouth of the river. The original gage consisted of an inclined and a vertical section, spiked to the east end of the south pier of the bridge and anchored with rocks. The present gage is of the wire type, and is located on the downstream side of the bridge between the fifth and seventh verticals from the right bank. The length of the wire from the end of the weight to the marker is 27.21 feet. The distance from the end of the scale board to the outside edge of the pulley is 2.00 feet. The gage is read once each day by W. A. Kelso. Discharge measurements are made from the upstream side of the bridge to which the gage is attached. There is a stay wire 70 feet above the bridge. The initial point for soundings is a point on the west side of the bridge 100 feet south of the center of the south pier of the main span. The channel is straight for 500 feet above and for 400 feet below the station. The current has a moderate velocity. The right bank is low, but is well protected by a levee and is not subject to overflow. The left bank is somewhat higher and is not subject to overflow. The bed of the stream is composed of fine gravel, not subject to change. At low water the river flows beneath the middle main span; at high water it passes under an additional shorter span at each end of the bridge. Bench mark No. 1 is the top of a spike in the east end of the cap of the first trestlebent on the right bank. Its elevation above gage datum is 20.94 feet. Bench mark No. 2 is a spike on the north side of the stay-wire post on the right bank. Its elevation above gage datum is 18.73 feet. Bench mark No. 3 is a nail in

the upstream end of the first trestle bent on the left bank. Its elevation is 18.73 feet above gage datum. The top of the 2-inch pulley is 25.62 feet above gage datum. The United States Geological Survey standard iron bench-mark post, near the Northern Pacific Railroad station, has an elevation above sea level of 515 feet. The elevation of gage datum above sea level is 453 feet. All bench marks are marked "B. M." with black paint.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Yakima River at Kiona, Wash., in 1904.

Date.	Hydrographer	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
June 6	G. F. Harley	326	2,600	5.34	10.59	13,880
September 8	do	205	528	.41	2.70	217

Mean daily gage height, in feet, of Yakima River at Kiona, Wash., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.45	5.55	5.20	6.05	13.05	10.65	8.20	4.40	2.70	3.10	3.60	6.65
2	5.40	5.50	5.15	6.25	12.10	10.20	8.35	4.30	2.70	3.20	3.60	6.40
3	5.40	5.50	5.15	6.90	11.45	10.30	8.45	4.20	2.75	3.20	3.65	6.65
4	5.35	5.50	5.10	7.10	10.80	10.25	8.70	4.10	2.75	3.25	3.85	6.50
5	5.35	5.45	5.00	7.95	10.60	10.40	8.90	4.00	2.75	3.25	4.00	5.90
6	5.30	5.40	5.05	8.10	10.25	10.65	8.80	3.90	2.75	3.30	4.00	5.80
7	5.25	5.40	5.70	9.05	9.85	10.90	8.55	3.85	2.75	3.30	4.05	5.70
8	5.20	5.35	7.40	8.65	9.50	10.65	8.40	3.80	2.65	3.30	4.05	5.60
9	5.20	5.30	7.55	8.50	9.30	10.00	8.15	3.80	2.70	3.30	4.15	5.45
10	5.35	5.25	7.50	8.80	9.20	9.60	7.75	3.80	2.70	3.30	4.10	5.40
11	5.35	5.25	7.50	9.20	9.15	9.30	7.45	3.60	2.70	3.35	4.15	5.30
12	5.35	5.25	7.50	10.90	9.10	9.05	7.20	3.60	2.70	3.35	4.10	5.35
13	5.30	5.25	7.10	11.80	9.20	8.75	7.05	3.50	2.65	3.90	4.15	5.25
14	5.90	5.15	6.85	12.55	9.30	8.70	6.70	3.45	2.65	3.95	4.10	5.20
15	6.55	5.20	6.80	13.50	9.50	8.75	6.50	3.40	2.65	3.95	4.20	5.15
16	6.90	5.20	6.65	14.60	9.85	9.15	6.20	3.35	2.70	3.90	4.20	5.40
17	7.00	5.15	6.45	15.00	10.25	9.40	5.95	3.30	2.70	3.80	4.15	5.80
18	7.05	5.10	6.45	14.40	10.25	9.55	5.75	3.30	2.70	3.80	4.20	5.90
19	6.80	5.00	6.35	13.65	10.30	9.90	5.60	3.20	2.75	3.75	4.20	7.00
20	6.60	5.10	6.35	13.45	10.35	9.75	5.45	3.00	2.75	3.75	4.20	7.00
21	6.20	5.05	6.35	13.55	10.40	9.50	5.25	3.00	2.75	3.75	4.30	6.15
22	6.20	5.05	6.30	13.55	10.70	9.25	5.20	3.00	2.70	3.75	6.20	6.20
23	6.20	5.05	6.20	13.25	11.45	9.05	5.15	2.95	2.70	3.80	6.80	6.30
24	6.20	5.20	6.10	12.75	11.90	8.60	5.05	2.90	2.75	3.80	6.70	6.20
25	5.90	5.35	6.00	11.85	12.35	8.15	5.00	2.90	2.75	3.75	6.60	6.00
26	5.95	5.25	5.90	11.60	11.75	7.80	4.90	2.90	2.75	3.75	6.30	5.80
27	5.85	5.25	5.85	11.35	11.00	7.75	4.80	2.80	2.80	3.70	6.50	5.65
28	5.80	5.25	5.75	11.80	10.75	7.70	4.75	2.75	3.00	3.65	6.30	5.60
29	5.70	5.25	5.70	12.50	10.70	7.90	4.65	2.65	3.00	3.60	6.45	5.50
30	5.60	.....	5.80	13.05	10.80	8.00	4.55	2.65	3.10	3.65	6.15	5.50
31	5.65	.....	5.80	.....	10.75	.....	4.50	2.70	.....	3.70	.....	5.80

Rating table for Yakima River at Kiona, Wash., from January 1, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.60	195	4.30	1,160	6.00	3,320	8.40	8,350
2.70	215	4.40	1,250	6.10	3,480	8.60	8,830
2.80	245	4.50	1,350	6.20	3,650	8.80	9,320
2.90	280	4.60	1,450	6.30	3,820	9.00	9,820
3.00	315	4.70	1,560	6.40	3,990	9.20	10,320
3.10	355	4.80	1,670	6.50	4,170	9.40	10,840
3.20	395	4.90	1,780	6.60	4,350	9.60	11,360
3.30	440	5.00	1,900	6.70	4,540	9.80	11,880
3.40	490	5.10	2,020	6.80	4,740	10.00	12,400
3.50	555	5.20	2,150	6.90	4,950	10.50	13,720
3.60	620	5.30	2,280	7.00	5,160	11.00	15,100
3.70	690	5.40	2,420	7.20	5,600	11.50	16,580
3.80	760	5.50	2,560	7.40	6,040	12.00	18,080
3.90	835	5.60	2,700	7.60	6,480	13.00	21,080
4.00	910	5.70	2,850	7.80	6,940	14.00	24,080
4.10	990	5.80	3,000	8.00	7,400	15.00	27,080
4.20	1,070	5.90	3,160	8.20	7,870		

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1903 and 1904. It is well defined to gage height, 9.00 feet. The table has been extended beyond this limit.

Estimated monthly discharge of Yakima River at Kiona, Wash., for 1904.

[Drainage area, 5,230 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	5,270	2,150	3,144	193,300	0.601	0.693
February	2,630	1,900	2,234	128,500	.427	.461
March	6,370	1,900	3,800	233,700	.727	.838
April	27,080	3,400	15,800	940,200	3.02	3.37
May	21,230	10,070	13,860	852,200	2.65	3.06
June	14,820	6,710	10,690	636,100	2.04	2.28
July	9,570	1,350	4,654	286,200	.890	1.03
August	1,250	205	551	33,880	.105	.121
September	355	205	232	13,800	.044	.049
October	872	355	620	38,120	.119	.137
November	4,740	620	1,892	112,600	.362	.404
December	5,160	2,085	3,166	194,700	.605	.698
The year	27,080	205	5,054	3,663,000	.966	13.14

KACHESS RIVER NEAR EASTON, WASH.

This station was established October 14, 1903, by G. H. Bliss. It is located 2 miles northwest of Easton, Wash., and one-half mile below the foot of Lake Kachess, at which a dam is being constructed by the Cascade Canal Company. The gage is an inclined rod on the left bank, directly under the cable. The gage is read once each day by W. W. Johnson. Discharge measurements are made by means of a cable car, tagged wire, and stay wire. The cable is of one-half inch plow steel and has a span of 120 feet. The initial point for soundings is the south side of the aspen tree to which the cable is fastened, on the left bank. The channel is straight for 600 feet above and for 150 feet below the station. The current is swift. Both banks are high, wooded, and not liable to overflow. The bed of the stream is composed of gravel and rocks, free from vegetation. The bench mark is the top of a large wire nail driven into the south side of the large aspen tree to which the cable is fastened, on the left or north bank. The tree is blazed and is marked "B. M." with black paint. The nail is near the base of the tree and has an elevation of 11.27 feet above the zero of the gage.

During periods noted in the table of gage heights the wasteway of the dam was closed and the entire flow of the river impounded. The tabulated mean monthly discharge for the months affected is the average for the entire month, including the period during which the wasteway was closed. No water is diverted above the gaging station.

Observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Kachess River near Easton, Wash., in 1903 and 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1903.		*Feet.*	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
October 14	G. H. Bliss	72	206	3.11	5.30	642
1904.						
May 12	G. F. Harley	74	193	2.73	5.06	527
May 18 [a]	G. H. Bliss	.....	5	2.0	2.65	10
June 14	G. F. Harley	73	235	3.42	5.64	805
July 12	do	.....	140	2.32	4.27	326
July 20	do	.....	119	2.00	3.97	239
August 3	do	68	95	1.56	3.61	148
August 24	do	63	71	.90	3.26	64

[a] Floats, below station.

Mean daily gage height, in feet, of Kachess River near Easton, Wash., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.90	4.00	(a)	3.70	5.90	6.00	4.00	3.60	3.50	4.25	3.30	4.10
2	3.90	4.00	(a)	3.70	5.70	5.80	4.10	3.50	3.50	3.80	3.30	4.35
3	3.90	3.90	(a)	3.70	5.60	5.95	4.50	3.40	3.50	3.70	3.30	4.35
4	3.90	3.90	(a)	3.70	5.60	6.00	5.50	3.60	3.50	3.80	3.30	4.35
5	3.90	3.90	(a)	3.70	5.50	6.25	5.20	3.40	3.55	3.75	3.20	4.25
6	3.80	3.90	4.20	3.70	5.40	6.30	5.10	3.40	3.50	3.70	3.20	.....
7	3.80	3.90	4.60	3.70	5.40	6.20	5.00	3.40	3.50	3.65	3.20	.....
8	3.80	3.80	4.50	3.70	5.40	6.05	4.50	3.50	3.50	3.65	3.20	.....
9	3.80	3.80	4.50	3.70	5.30	6.00	4.40	3.60	3.50	3.60	3.20	.....
10	4.00	3.80	4.50	3.80	5.20	5.90	4.40	3.55	3.50	3.70	3.20	.....
11	4.00	3.80	4.50	3.80	5.20	5.80	4.40	3.50	3.50	3.60	3.20	.....
12	4.10	3.80	4.40	4.00	5.10	5.60	4.30	3.50	3.45	3.60	3.20	.....
13	4.20	3.80	4.40	4.00	5.15	5.60	4.20	3.50	3.25	3.60	3.20	.....
14	4.30	3.80	4.30	(a)	5.25	5.70	4.10	3.50	3.40	3.60	3.20	.....
15	4.40	3.80	4.20	(a)	5.30	5.60	4.10	3.50	3.50	3.60	3.20	.....
16	4.50	3.80	4.10	(a)	5.30	5.60	4.10	3.40	3.70	3.60	3.20	4.40
17	4.50	3.80	4.10	5.70	4.50	5.60	4.10	3.40	3.70	3.60	3.30	4.50
18	4.50	3.80	4.10	6.20	(a)	5.70	4.00	3.30	3.40	3.60	3.35	4.55
19	4.50	3.80	4.00	6.10	(a)	5.70	4.00	3.30	3.70	3.50	3.40	4.60
20	4.50	3.50	4.00	6.00	(a)	5.60	4.00	3.30	3.00	3.60	3.75	4.65
21	4.50	3.50	4.00	6.00	(a)	5.60	4.00	3.30	3.85	3.50	3.90	4.65
22	4.40	3.50	3.90	5.90	4.30	5.50	3.90	3.25	3.90	3.50	4.00	4.65
23	4.30	3.60	3.90	5.90	4.80	5.40	3.90	3.50	3.85	3.30	4.10	4.65
24	4.30	(a)	3.80	5.80	5.10	5.30	3.80	3.55	3.80	3.40	4.10	4.60
25	4.20	(a)	3.80	5.60	5.10	5.20	3.80	3.55	3.80	3.40	4.10	4.55
26	4.20	(a)	3.80	5.50	5.20	5.15	3.80	3.55	3.80	3.40	4.10	4.50
27	4.10	(a)	3.70	5.60	5.30	4.90	3.80	3.55	3.90	3.40	4.10	4.40
28	4.10	(a)	3.70	5.70	5.40	4.40	3.75	3.55	3.90	3.30	4.25	4.40
29	4.00	(a)	3.70	5.90	5.50	4.15	3.80	3.55	3.80	3.29	4.35	4.40
30	4.00	.....	3.70	5.90	5.90	3.90	3.60	3.55	3.80	3.30	4.35	4.35
31	4.00	.....	3.70	.....	6.00	.....	3.60	3.55	.....	3.30	.....	4.30

[a] Water shut off at dam.

Rating table for Kachess River near Easton, Wash., from November 20, 1903, to December 31 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.60	9	3.60	145	4.60	420	5.60	785
2.70	12	3.70	170	4.70	450	5.70	825
2.80	17	3.80	195	4.80	485	5.80	865
2.90	24	3.90	220	4.90	520	5.90	910
3.00	33	4.00	245	5.00	555	6.00	955
3.10	44	4.10	270	5.10	590	6.10	1,000
3.20	57	4.20	300	5.20	625	6.20	1,050
3.30	73	4.30	330	5.30	665	6.30	1,100
3.40	95	4.40	360	5.40	705	6.40	1,150
3.50	120	4.50	390	5.50	745	6.50	1,200

The preceding table is applicable only for open-channel conditions. It is based upon 8 discharge measurements made during 1903 and 1904. It is well defined between gage heights 2.60 feet and 5.60 feet. The table has been extended beyond these limits. Above gage height 6.10 feet the rating curve is a tangent, the difference being 50 per tenth.

Estimated monthly discharge of Kachess River near Easton, Wash., for 1903 and 1904.

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1903.						
November 20–30	530	170	353	7,702	5.60	2.29
December	745	245	426	26,190	6.76	7.79
1904.						
January	390	195	286	17,580	4.54	5.23
February	245	[b]0	153	8,801	2.43	2.62
March	420	[b]0	227	13,960	3.60	4.15
April	1,050	[b]0	495	29,460	7.86	8.77
May	955	[b]0	588	36,160	9.33	10.76
June	1,100	220	778	46,290	12.30	13.72
July	745	145	305	18,750	4.84	5.58
August	145	65	113	6,948	1.79	2.06
September	220	33	147	8,747	2.33	2.60
October	315	73	138	8,485	2.19	2.52
November	345	57	141	8,390	2.24	2.50
December[a]			376	23,120	5.97	6.88
The year			312	226,700	4.95	67.39

[a] Discharge December 6 to 15 interpolated. [b] Water shut off at dam.

CLEALUM RIVER NEAR ROSLYN, WASH.

This station was established October 10, 1903, by G. H. Bliss. It is located 1,000 feet below the outlet of Lake Clealum. It is 2½ miles northwest of Roslyn and 6½ miles northwest of Clealum, Wash. The gage is an inclined rod on the left bank, 20 feet upstream from the cable. It is read once each day by Charles M. Davis. Discharge measurements are made by means of a cable, car, tagged wire, and stay wire. The initial point for soundings is the south face of the black pine tree, 18 inches in diameter, to which the cable is fastened, on the left bank. The channel is straight for 300 feet above and for 900 feet below the station. The current is swift. Both banks are high, not liable to overflow, and are heavily timbered. The bed of the stream is composed of gravel, free from vegetation, and permanent. The bench mark is a large spike driven into the root of the

tree to which the cable is fastened, on the left bank. The root is on the east or downstream side of the tree, and the tree is blazed. The elevation of the bench mark is 17.40 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Clealum River near Roslyn, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1904.		*Feet.*	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 11	G. F. Harley	130	906	1.46	4.05	1,319
May 18	Bliss and Murphy	141	1,146	2.46	5.60	2,820
May 23	G. F. Harley	154	1,383	3.22	7.15	4,459
June 13	do	135	1,036	1.98	4.85	2,048
June 22	do	140	1,124	2.29	5.50	2,580
July 20	do	127	809	1.11	3.22	897
August 4	do	123	763	0.91	2.81	693
August 18	do	120	696	0.69	2.27	480
August 31	do	118	649	0.58	1.86	378
September 22	do	117	608	0.36	1.49	220
September 26 [a]	do	148	187	1.17	1.38	219

[a] Wading 800 feet above station.

Mean daily gage height, in feet, of Clealum River near Roslyn, Wash., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept	Oct.	Nov.	Dec.
1	2.10	2.50	1.70	1.65	5.45	6.00	5.70	2.85	1.80	1.55	1.30	2.80
2	2.05	2.35	1.70	1.70	5.30	5.90	5.80	2.85	1.75	1.60	1.35	2.75
3	2.00	2.10	1.68	1.70	5.10	5.95	5.70	2.80	1.70	1.55	1.35	2.65
4	2.01	2.08	1.65	1.90	4.90	6.50	5.60	2.80	1.70	1.50	1.35	2.60
5	2.00	2.03	1.65	2.00	4.70	6.70	5.45	2.80	1.70	1.50	1.45	2.50
6	2.00	2.00	1.70	2.10	4.55	6.90	5.45	2.75	1.70	1.50	1.45	2.40
7	1.95	2.00	1.70	2.20	4.35	6.50	5.40	2.75	1.70	1.45	1.45	2.20
8	1.97	1.50	1.73	2.20	4.30	6.10	5.20	2.75	1.70	1.40	1.45	2.10
9	2.00	1.90	1.75	2.35	4.10	5.60	5.00	2.70	1.70	1.40	1.50	2.00
10	2.20	1.85	1.75	3.35	3.90	5.40	4.85	2.70	1.70	1.35	1.55	2.00
11	2.20	1.90	2.00	3.60	4.00	5.20	4.70	2.65	1.65	1.45	1.55	1.95
12	2.35	1.95	2.20	4.80	4.20	4.90	4.55	2.50	1.60	1.50	1.55	1.90
13	2.50	2.00	2.30	5.70	4.50	4.95	4.35	2.45	1.55	1.55	1.55	1.90
14	2.90	1.90	2.20	6.10	4.65	5.00	4.10	2.40	1.50	1.60	1.45	2.00
15	3.20	1.90	2.10	6.60	5.25	5.40	3.85	2.35	1.45	1.65	1.45	2.30
16	3.27	1.90	2.05	6.70	5.40	5.75	3.60	2.30	1.40	1.65	1.50	2.50
17	3.20	1.85	2.10	6.35	5.45	5.80	3.45	2.30	1.40	1.65	1.60	2.60
18	3.20	1.80	2.20	5.90	5.60	6.00	3.40	2.25	1.40	1.60	1.80	2.70
19	3.00	1.80	2.20	5.60	5.80	6.20	3.30	2.25	1.40	1.55	1.90	2.80
20	2.90	1.80	2.35	5.50	6.30	5.90	3.20	2.20	1.40	1.50	2.10	2.75
21	2.85	1.82	2.35	5.50	6.45	5.70	3.15	2.15	1.40	1.50	2.60	2.70
22	2.77	1.80	2.20	5.50	6.80	5.50	3.20	2.10	1.40	1.50	2.70	2.65
23	2.70	1.85	2.20	5.45	7.05	5.15	3.25	2.10	1.40	1.50	2.90	2.60

Mean daily gage height, in feet, of Clealum River near Roslyn, Wash., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
24	2.60	1.90	1.90	5.45	7.20	4.80	3.25	2.05	1.40	1.50	2.85	2.60
25	2.50	1.90	1.90	5.00	6.80	4.50	3.20	1.95	1.35	1.45	2.75	2.50
26	2.40	1.85	1.65	4.90	6.50	4.50	3.15	1.90	1.30	1.40	2.60	2.40
27	2.40	1.80	1.65	4.70	6.10	4.60	3.15	1.80	1.30	1.30	2.60	2.30
28	2.30	1.83	1.70	5.60	6.10	4.90	3.15	1.80	1.35	1.20	2.80	2.20
29	2.27	1.75	1.60	6.50	6.20	5.10	3.10	1.80	1.40	1.20	2.90	2.10
30	2.20	.....	1.63	6.55	6.25	5.40	3.00	1.80	1.50	1.20	2.85	2.15
31	2.70	.....	1.60	.....	6.15	.....	2.90	1.80	.....	1.25	.....	2.20

Rating table for Clealum River near Roslyn, Wash., from October 10, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.20	165	2.80	685	4.30	1,520	5.80	2,890
1.30	190	2.90	725	4.40	1,590	5.90	2,990
1.40	215	3.00	770	4.50	1,670	6.00	3,100
1.50	240	3.10	815	4.60	1,750	6.10	3,210
1.60	270	3.20	865	4.70	1,830	6.20	3,320
1.70	300	3.30	915	4.80	1,920	6.30	3,430
1.80	330	3.40	965	4.90	2,010	6.40	3,540
1.90	360	3.50	1,020	5.00	2,100	6.50	3,660
2.00	390	3.60	1,075	5.10	2,190	6.60	3,780
2.10	425	3.70	1,130	5.20	2,290	6.70	3,900
2.20	460	3.80	1,185	5.30	2,390	6.80	4,020
2.30	495	3.90	1,245	5.40	2,490	6.90	4,140
2.40	530	4.00	1,310	5.50	2,590	7.00	4,260
2.50	565	4.10	1,380	5.60	2,690	7.10	4,390
2.60	605	4.20	1,450	5.70	2,790	7.20	4,520
2.70	645						

The above table is applicable only for open-channel conditions. It is based upon 12 discharge measurements made during 1903 and 1904. It is well defined between gage heights 1.20 feet and 7.20 feet.

Estimated monthly discharge of Clealum River near Roslyn, Wash., for 1903 and 1904.

[Drainage area, 205 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1903.						
October 10-31	1,534	589	967	42,200	4.72	3.86
November	1,630	478	746	44,390	3.64	4.06
December	3,900	425	1,022	62,840	4.98	5.74
1904.						
January	900	375	567	34,860	2.77	3.19
February	565	240	367	21,110	1.79	1.93
March	512	270	367	22,570	1.79	2.06
April	3,900	285	1,971	117,300	9.61	10.72
May	4,520	1,245	2,629	161,700	12.82	14.78
June	4,140	1,670	2,676	159,200	13.05	14.56
July	2,890	725	1,512	92,970	7.38	8.51
August	705	330	517	31,790	2.52	2.90
September	330	190	250	14,880	1.22	1.36
October	285	165	234	14,390	1.14	1.31
November	725	190	391	23,270	1.91	2.13
December	685	360	527	32,400	2.57	2.96
The year	4,520	165	1,001	726,400	4.88	66.41

NACHES RIVER NEAR NILE, WASH.

This station was established June 25, 1904, by G. F. Harley. It is located 1¾ miles above the highway bridge, 23 miles northwest of North Yakima, and 8 miles southeast of Nile, Wash. The station is 1¾ miles above the junction of Naches and Tieton rivers. An inclined staff gage, graduated to read direct to feet and tenths, is fastened to timbers buried on the left bank. The gage is read once each day by W. F. White. Discharge measurements are made by means of a cable, car, and tagged wire, at the gage. The cable has a span of 216 feet. The initial point for soundings is the south face of the pine to which the cable is fastened on the north bank. The channel is straight for about 600 feet above and 300 feet below the station. The current is moderate at the station, and swift above and below. The right bank is low, wooded, and overflows only during extreme high floods. The left bank is high, rocky, clean, and not liable to overflow. The bed of the stream is composed of clean gravel and cobbles, and is permanent. There is one channel at all except very

high stages, when there are two. The section is flat and shallow. Bench mark No. 1 is a point on the ledge 25 feet upstream from the tree supporting the cable on the north bank, marked with a cross and "B. M." Its elevation is 9.85 feet above the zero of the gage. Bench mark No. 2 is a large spike in the base of a 30-inch pine tree 115 feet upstream from the north cable support. Its elevation is 8.76 feet above the zero of the gage. Bench mark No. 3 is a United States Geological Survey standard bronze tablet set in a bowlder 700 feet east of north cable support, 300 feet from the river, marked on the tablet "1661." Its exact elevation is 1,660.824 feet above sea level and 9.20 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Naches River near Nile, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
June 25	G. F. Harley	192	490	4.39	5.25	2,150
July 6	do	192	540	5.00	5.55	2,720
July 16	do	190	370	3.43	4.63	1,270
July 28	do	190	290	2.78	4.25	805
August 12	do	189	215	2.16	3.84	465
September 6	J. C. Dry	186	182	1.70	3.61	310

Mean daily gage height, in feet, of Naches River near Nile, Wash., for 1904.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		5.80	4.10	3.50	3.20	3.30	4.40
2		5.80	4.10	3.50	3.30	3.30	4.30
3		5.70	4.10	3.50	3.30	3.30	4.20
4		5.70	4.10	3.40	3.30	3.30	4.10
5		5.70	4.00	3.40	3.30	3.30	4.00
6		5.60	4.00	3.40	3.30	3.30	4.00
7		5.50	4.00	3.20	3.30	3.35	3.90
8		5.40	4.00	3.10	3.30	3.40	3.90
9		5.30	4.00	3.10	3.30	3.40	3.80
10		5.20	3.70	3.20	3.30	3.40	3.80
11		5.10	3.70	3.10	3.50	3.40	3.80
12		5.10	3.70	3.05	3.70	3.40	3.80
13		5.00	3.70	3.05	3.50	3.35	3.80
14		4.80	3.60	3.05	3.60	3.30	4.10
15		4.70	3.60	3.05	3.55	3.35	4.00
16		4.60	3.60	3.05	3.40	3.40	4.00
17		4.60	3.60	3.05	3.45	3.45	4.00
18		4.50	3.50	3.00	3.50	3.50	4.00
19		4.50	3.50	3.00	3.45	3.50	4.00
20		4.40	3.50	3.00	3.40	4.00	4.00
21		4.40	3.50	3.00	3.45	5.05	4.10
22		4.50	3.50	3.10	3.45	5.40	4.00

Mean daily gage height, in feet, of Naches River near Nile, Wash., for 1904—Continued.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
23	.....	4.50	3.50	3.10	3.40	5.20	3.90
24	.....	4.40	3.50	3.10	3.30	4.80	3.80
25	5.30	4.40	3.50	3.10	3.30	4.60	3.80
26	5.30	4.30	3.50	3.05	3.30	4.80	3.90
27	5.40	4.30	3.50	3.05	3.30	4.70	3.80
28	5.50	4.30	3.50	3.05	3.30	5.00	3.80
29	5.60	4.20	3.50	3.05	3.30	4.80	3.90
30	5.70	4.20	3.50	3.05	3.30	4.70	4.00
31	.....	4.20	3.50	.....	3.30	.....	3.90

Rating table for Naches River near Nile, Wash., from June 25 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.00	139	3.90	496	4.80	1,476	5.70	2,997
3.10	158	4.00	576	4.90	1,614	5.80	3,185
3.20	181	4.10	664	5.00	1,760	5.90	3,373
3.30	208	4.20	760	5.10	1,914	6.00	3,561
3.40	239	4.30	864	5.20	2,078	6.10	3,749
3.50	274	4.40	975	5.30	2,250	6.20	3,937
3.60	316	4.50	1,093	5.40	2,433	6.30	4,125
3.70	366	4.60	1,216	5.50	2,621	6.40	4,313
3.80	425	4.70	1,344	5.60	2,809	6.50	4,501

The above table is applicable only for open-channel conditions. It is based upon 6 discharge measurements made during 1904. It is well defined between gage heights 3.61 feet and 5.55 feet. The table has been extended beyond these limits. Above gage height 5.50 feet the rating curve is a tangent, the difference being 188 per tenth.

Estimated monthly discharge of Naches River near Nile, Wash., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
June 25-30	2,997	2,250	2,560	30,470
July	3,185	760	1,662	102,200
August	664	274	390	23,980
September	274	139	173	10,290
October	366	181	234	14,390
November	2,433	208	713	42,430
December	975	425	553	34,000
The period	.....	.....	.....	257,800

NACHES RIVER NEAR NORTH YAKIMA, WASH.

Naches River has its source in the Cascade Mountains, Yakima County, Wash., and flows southeasterly, entering Yakima River a short distance above North Yakima. Its principal tributaries are Tieton River, Cowiche, Rattlesnake, and Nile creeks, and Bumping River. The flow of the latter has already been increased by American River when it joins the Naches.

Naches River is important because of its rapid fall and the ease with which it can be used for irrigation purposes. Naches Valley, through which it flows, is already extensively irrigated from it. It is also the source of domestic water supply for the town of North Yakima and of water supply and power for the Northwestern Light and Water Company.

Two gaging stations are at present maintained upon Naches River, one near its junction with the Yakima and one just above the mouth of the Tieton.

The original station on Naches River was established August 14, 1893, by Mr. F. H. Newell, at a point a few hundred yards above the mouth of the river, near the bridge of the Northern Pacific Railroad.

The first gage, known as No. 1, was vertical and was nailed to the cribwork on the right-hand side of the river, above the railroad bridge. The 12-foot mark was 9.97 feet below the top of the rail on the bridge, the gage being about 60 feet easterly from the rail. The top of the iron pier, on the southeast end of the county bridge, was 5.87 feet above this 12-foot mark. Measurements were made from the county bridge. The locality was, however, not favorable for the purpose, as the water was very swift and was broken by the piers of the bridge. Owing to the difficulty of securing accurate measurements the readings were discontinued on September 20, 1894, and not resumed until August 19, 1895.

When the station was visited in July, 1896, it was found that the channel under the bridge, from which previous gagings had been made, had been greatly changed by the deposition of several carloads of rock and by the building of a short wing dam placed just above the gage rod. On July 28 gage No. 1 was removed and gage No. 2 fastened to the bulwark just above the highway bridge, and about 100 yards above its old position. The gage height in its old position when removed was 3.8, in its new position when placed 2.4. When the station was visited October 21 it was found that the water had fallen below the end of gage No. 2, and it was therefore removed and fastened again to the bulwark just below the highway bridge, and lowered in elevation 1 foot. Before changing, the gage height was −0.24 foot; after the change it was 0.76 foot. The gage-height records for 1896 are referred to this gage, known as gage No. 3.

The flood of November, 1896, modified the channel very greatly, depositing a large mass of coarse gravel and small bowlders along the right side of the channel at the section, so that the rod was about 50 feet from the edge of the water at low stages. The current is swift, even at low water. On account of the instability of the channel the station was abandoned in February, 1897, although a number of discharge measurements were made during the season.

May 19, 1897, a station was established on Yakima River 5 miles above the mouth of the Naches, at the Northern Pacific Railway bridge near Selah, Wash., with the idea that the difference in discharge between this station and the one at Union Gap would give approximately the discharge of Naches River. Two ditches, located in the Moxee Valley, took water out of the river between these two points, but their combined flow was about counterbalanced by that received from Atanum Creek and the Wide Hollow wastage at Old Town.

The station on Naches River was reestablished February 1, 1898, and the station at Selah, on Yakima River, was discontinued. Since the reestablishment of the Naches station the river channel has been in a condition more favorable for meter observations than formerly. Discharge measurements were made from the lower side of the highway bridge. A new horizontal gage rod, No. 4, with wire and weight, was attached to the main span of the Northern Pacific Railway bridge at the mouth of the Naches, a few hunderd feet downstream from the highway bridge. The length of the gage wire from index to foot of weight was 30.41 feet. The elevation of top of pulley was 24.57 feet. The bench mark was the top of the north end of east sill of clearance posts, about 150 feet north of Northern Pacific Railway bridge. Elevation, 23.77 feet above zero of gage. On December 27, 1898, the top of the northeast concrete pier of the highway bridge was found to be at an elevation of 22.09 feet above zero.

On June 20, 1899, the gage rod and bench mark having been disturbed during alterations to the railroad bridge and approaches, a new 4 by 4 inch inclined gage rod, No. 5, was established on the left bank of the river, 30 feet downstream from the railroad bridge. This is the gage in present use. The lower section of the rod is inclined at an angle of 36° 30′ with the horizontal. The upper section is inclined at an angle of 80° with the horizontal.

On September 21, 1903, the station was changed to a location between the railroad and highway bridge and equipped with a cable, car, tagged wire, and stay wire. The cable is located 180 feet above the Northern Pacific Railway bridge, and 170 feet below the highway bridge, at which discharge measurements were formerly made. The stay wire is 85 feet above the cable. The cable has a total span of 280 feet. The initial point for soundings is the south face of the

cottonwood tree to which the cable is fastened on the north bank. The channel is straight for 100 feet above and for 75 feet below the cable. The current is swift. Both banks are low and covered with gravel. At flood stages the rock-filled crib will prevent overflow on both banks. The bed of the stream is composed of gravel, free from vegetation, and somewhat shifting. Although the present location does not have many of the characteristics of an ideal gaging station it has more of them than any location below the Tieton.

Naches River below the Tieton, almost to the point where it enters the Yakima, flows over flat bars of river gravel in numerous, crooked, and constantly changing channels. These gravel bars are in some instances one-half mile in width.

The datum of gage board No. 5, now in use, has been referred to the following bench marks: Bench mark No. 1 is a United States Geological Survey copper plug marked "1090 T" and its elevation is 1,089.959 feet above sea level and 19.74 above the zero of the gage. It is located in the center of the west end of the most southerly stone pier of the railroad bridge. The elevation of the zero of the gage is 1,070.22 feet above sea level. Bench mark No. 2 is a cross in the top of the center of the downstream end of the railroad bridge pier on the right bank. Its elevation above the zero of the gage is 19.94 feet and above sea level is 1,090 feet. Bench mark No. 3 is a railroad spike driven into the south side of the telegraph pole 23 feet north of the gage and 21 feet east of the railroad track. Its elevation is 17.81 feet above the zero of the gage. The observer is Patrick Gallagher, section foreman for the Northern Pacific Railway, who lives in North Yakima.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Naches River near North Yakima, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
April 26	G. F. Harley	182	757	6.29	8.30	4,764
April 29	do	228	1,031	7.46	9.45	7,696
May 6	do	180	670	5.13	7.59	3,420
June 18	do	208	835	6.16	8.47	5,140
June 28	do	177	665	4.81	7.35	3,201
July 13	do	171	526	4.10	6.61	2,159
July 19	do	128	390	3.05	5.71	1,190
July 30	do	125	322	2.52	5.13	810
August 9	do	123	268	2.19	4.73	588
August 17	do	120	222	1.69	4.29	375
September 1	J. C. Dry	118	178	1.26	3.95	225
September 13	G. F. Harley	117	165	1.24	3.80	205

Mean daily gage height, in feet, of Naches River near North Yakima, Wash., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.10	5.90	5.70	6.10	8.80	8.30	7.80	5.10	4.00	4.00	4.00	6.00
2	6.10	5.90	5.60	6.20	8.40	8.20	7.80	5.00	3.90	3.95	3.90	5.80
3	6.10	5.90	5.60	6.50	8.20	8.20	7.80	5.00	3.80	3.90	3.90	5.60
4	6.10	5.90	5.60	6.80	8.20	8.30	7.80	4.90	3.75	3.90	3.90	5.45
5	6.10	5.80	5.60	6.80	7.90	8.50	7.90	4.90	3.70	3.90	3.90	5.30
6	6.00	5.80	5.70	7.50	7.70	8.70	7.70	4.80	3.70	3.80	4.00	5.20
7	6.00	5.80	5.80	7.30	7.40	8.60	7.60	4.80	3.60	3.80	4.10	5.10
8	6.00	5.80	6.20	7.30	7.40	8.20	7.50	4.80	3.60	3.80	4.20	5.00
9	6.00	5.80	6.20	7.40	7.40	7.80	7.20	4.70	3.60	3.85	4.20	5.00
10	6.00	5.80	6.60	8.20	7.40	7.80	7.10	4.60	3.60	3.90	4.10	5.00
11	6.00	5.80	6.50	8.90	7.40	7.60	7.00	4.50	3.65	4.00	4.10	4.95
12	6.00	5.80	6.40	9.50	7.60	7.40	6.90	4.50	3.70	4.70	4.10	4.90
13	6.00	5.80	6.35	10.00	7.80	7.30	6.60	4.40	3.70	4.40	4.10	4.90
14	6.70	5.75	6.30	10.30	8.20	7.50	6.20	4.40	3.70	4.40	4.20	4.90
15	6.90	5.70	6.30	10.30	8.30	7.90	6.10	4.40	3.70	4.40	4.20	5.10
16	6.80	5.70	6.20	9.70	8.40	8.10	6.00	4.40	3.60	4.30	4.30	5.20
17	6.70	5.70	6.20	9.40	8.30	8.20	5.95	4.40	3.60	4.20	4.30	5.20
18	6.60	5.70	6.20	9.00	8.40	8.50	5.90	4.30	3.60	4.10	4.30	5.20
19	6.50	5.70	6.20	9.30	8.50	8.30	5.80	4.30	3.60	4.10	4.30	5.20
20	6.50	5.70	6.15	9.50	8.60	8.10	5.70	4.20	3.60	4.10	5.45	5.20
21	6.40	5.70	6.10	9.50	8.90	8.00	5.70	4.15	3.60	4.00	6.60	5.20
22	6.40	5.70	6.10	9.10	9.30	7.90	5.70	4.10	3.70	4.00	6.70	5.10
23	6.40	5.80	6.00	8.70	9.70	7.60	5.70	4.10	3.70	4.00	6.60	5.10
24	6.25	5.80	6.00	8.50	9.50	7.20	5.65	4.10	3.80	4.00	6.20	5.10
25	6.10	5.80	6.00	8.20	9.00	7.00	5.60	3.90	3.80	4.00	6.10	5.00
26	6.00	5.80	6.00	8.30	8.60	7.00	5.60	3.90	3.80	4.00	6.10	4.90
27	6.00	5.80	5.95	8.90	8.50	7.10	5.60	3.80	3.80	4.00	6.25	4.90
28	6.00	5.75	5.90	9.30	8.50	7.30	5.40	3.90	3.90	4.00	6.40	4.90
29	6.00	5.70	5.90	9.70	8.55	7.50	5.20	4.00	3.90	4.00	6.30	4.90
30	6.00	.....	5.90	9.30	8.60	7.70	5.10	4.10	4.00	4.00	6.10	5.00
31	5.95	.....	6.00	.....	8.50	.....	5.10	4.00	.....	4.00	.....	5.20

NOTE.—Gage heights for Sundays interpolated.

Rating table for Naches River near North Yakima, Wash., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.60	163	5.00	725	6.40	1,882	7.80	3,856
3.70	182	5.10	781	6.50	2,004	7.90	4,025
3.80	205	5.20	839	6.60	2,128	8.00	4,199
3.90	232	5.30	898	6.70	2,255	8.20	4,585
4.00	263	5.40	961	6.80	2,384	8.40	5,040
4.10	298	5.50	1,028	6.90	2,515	8.60	5,539
4.20	335	5.60	1,099	7.00	2,648	8.80	6,051
4.30	374	5.70	1,174	7.10	2,785	9.00	6,563
4.40	415	5.80	1,253	7.20	2,926	9.20	7,075
4.50	458	5.90	1,339	7.30	3,071	9.40	7,587
4.60	507	6.00	1,433	7.40	3,220	9.60	8,099
4.70	559	6.10	1,535	7.50	3,373	9.80	8,611
4.80	613	6.20	1,645	7.60	3,530	10.00	9,123
4.90	669	6.30	1,762	7.70	3,691	10.20	9,635

The above table is applicable only for open-channel conditions. It is based upon 12 discharge measurements made during 1904. It is well defined between gage heights 3.80 feet and 9.45 feet. The table has been extended beyond these limits. Above gage height 8.60 feet the rating curve is a tangent, the difference being 256 per tenth.

Estimated monthly discharge of Naches River near North Yakima, Wash., for 1904.

[Drainage area, 1,000 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	2,530	1,400	1,691	104,000	1.69	1.95
February	1,350	1,180	1,245	71,610	1.24	1.34
March	2,140	1,110	1,511	92,910	1.51	1.74
April	9,890	1,550	5,706	339,500	5.71	6.37
May	8,360	3,230	5,016	308,400	5.02	5.79
June	5,800	2,660	4,074	242,400	4.07	4.54
July	4,030	780	2,076	127,600	2.08	2.40
August	780	210	436	26,810	.436	5.03
September	260	160	189	11,200	.189	.211
October	560	200	284	17,460	.284	.327
November	2,260	230	832	49,510	.832	.928
December	1,440	670	816	50,170	.816	.941
The year	9,890	160	1,989	1,442,000	1.99	27.04

TIETON RIVER NEAR NORTH YAKIMA, WASH.

The gaging station on this stream was established April 14, 1902, at a point immediately below the mouth of Oak Creek, in sec. 3, T. 14 N., R. 16 E. of the Willamette meridian, and about 22 miles from North Yakima by road. The gage rod is inclined at an angle of 55° with the horizontal, and is on the left bank of the stream. It consists of a 1 by 5 inch cedar plank, supported and braced by stout logs. The equipment with which measurements are made consists of a ⅝-inch cable, car, tag wire, and stay wire. The initial point for soundings is a cross chiseled in a ledge, with a black ring painted around it. It is under the cable, 4 feet east of the west shear legs. The observer is Omer Tetherow, a farmer. There are no side channels and the banks are not subject to overflow. The bed of the stream is rocky, with shifting gravel bars, which make it difficult to find suitable cross sections for meter measurements. The point selected for the station is, however, a fairly good one, and the channel is straight both above and below the station for several hundred yards. At low water the underground flow at this station is estimated to be as much as 50 per cent of the measured flow. Bench mark No. 1 is a point of rock on a ledge 12 feet from the gage. Its elevation above gage datum is 15.67. Bench mark No. 2 is a nail in a cottonwood stump 40 feet south of the gage. Its elevation above gage datum is 15.93. Bench mark No. 3 is top of a bowlder 20 feet northwest of the cable shear legs. Its elevation above gage datum is 17.52. The gage datum is 1,683.365 above sea level.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Tieton River near North Yakima, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
April 28	G. F. Harley	118	365	7.00	10.65	2,569
May 18	do	116	288	5.38	9.65	1,550
June 26	do	114	251	4.26	8.90	1,065
July 7	do	116	280	5.21	9.55	1,460
July 15	do	109	208	3.77	8.35	785
July 28	do	108	185	3.41	8.12	630
August 12	do	107	157	2.83	7.65	445
September 7	J. C. Dry	106	136	2.85	7.40	397

Mean daily gage height, in feet, of Tieton River near North Yakima, Wash., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.15	7.10	6.95	7.20	9.65	9.70	9.75	8.00	7.25	7.25	6.70	7.70
2	7.20	7.10	6.95	7.40	9.50	9.70	9.55	8.05	7.25	7.20	6.70	7.55
3	7.20	7.00	6.95	7.70	9.40	9.85	9.60	7.95	7.30	7.10	6.70	7.35
4	7.15	7.15	6.95	7.80	9.35	9.90	9.80	7.90	7.30	7.00	6.65	7.25
5	7.10	7.05	6.95	7.90	9.25	10.00	9.75	7.95	7.30	7.00	6.70	7.25
6	7.10	7.10	7.00	8.20	9.05	10.15	9.55	8.00	7.35	6.95	6.65	7.20
7	7.10	7.10	7.35	8.05	9.00	9.70	9.50	8.05	7.35	6.95	6.75	7.15
8	7.10	7.05	7.60	8.20	8.95	9.45	9.25	7.95	7.35	6.90	6.85	7.15
9	7.15	6.85	7.65	8.40	8.85	9.35	9.10	7.85	7.45	6.90	6.75	7.10
10	7.15	7.00	7.60	8.90	8.90	9.35	9.00	7.75	7.35	6.85	6.70	7.10
11	7.10	7.10	7.60	9.60	9.05	9.10	9.15	7.70	7.25	7.80	6.65	7.05
12	7.25	7.00	7.45	10.15	9.15	8.95	9.00	7.60	7.20	7.45	6.70	7.00
13	7.70	7.00	7.40	10.50	9.30	9.05	8.70	7.60	7.20	7.15	6.65	7.05
14	7.80	7.00	7.40	11.10	9.60	9.30	8.50	7.70	7.10	7.00	6.60	7.10
15	7.80	7.00	7.35	10.95	9.55	9.65	8.35	7.75	7.10	6.95	6.75	7.75
16	7.75	7.00	7.15	10.50	9.50	9.80	8.30	7.70	7.10	6.90	6.85	7.35
17	7.65	6.95	7.30	10.10	9.55	9.90	8.20	7.60	7.20	6.85	7.00	7.45
18	7.60	6.95	7.25	10.10	9.70	10.35	8.10	7.60	7.10	6.85	6.90	7.45
19	7.50	6.95	7.25	10.25	9.80	9.65	8.00	7.60	7.05	6.85	6.80	7.45
20	7.35	7.00	7.25	10.55	9.90	9.50	8.15	7.60	7.05	6.80	8.05	7.55
21	7.45	7.00	7.25	10.40	10.30	9.60	8.25	7.45	7.00	6.85	9.15	7.45
22	7.40	7.20	7.20	10.10	10.80	9.50	8.55	7.40	7.15	6.85	8.75	7.40
23	7.40	7.15	7.20	9.70	10.90	9.20	8.45	7.40	7.15	6.80	8.30	7.30
24	7.35	7.05	7.10	9.45	10.65	8.90	8.05	7.35	7.05	6.75	8.00	7.30
25	7.20	6.95	7.05	9.40	10.10	8.80	8.20	7.30	7.05	6.75	8.00	7.15
26	7.25	7.00	7.05	9.65	9.90	8.85	8.20	7.35	7.05	6.75	8.30	7.00
27	7.15	7.00	7.10	10.65	9.85	9.10	8.25	7.45	7.05	6.75	8.20	7.00
28	7.10	7.00	7.10	10.80	10.00	9.30	8.15	7.50	7.10	6.75	8.25	7.10
29	7.20	6.95	7.10	10.05	10.05	9.40	7.95	7.55	7.30	6.70	8.00	7.20
30	7.20	.....	7.15	9.55	10.05	9.65	7.90	7.40	7.25	6.70	7.80	7.90
31	7.10	.....	7.15	.....	9.85	.....	7.95	7.35	.....	6.70	.....	7.55

Rating table for Tieton River near North Yakima, Wash., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
6.50	210	7.80	500	9.10	1,180	10.40	2,250
6.60	220	7.90	540	9.20	1,240	10.50	2,370
6.70	233	8.00	580	9.30	1,300	10.60	2,490
6.80	249	8.10	625	9.40	1,370	10.70	2,620
6.90	267	8.20	670	9.50	1,440	10.80	2,750
7.00	287	8.30	720	9.60	1,510	10.90	2,880
7.10	308	8.40	775	9.70	1,590	11.00	3,010
7.20	330	8.50	830	9.80	1,670	11.20	3,270
7.30	353	8.60	885	9.90	1,750	11.40	3,530
7.40	376	8.70	940	10.00	1,840	11.60	3,790
7.50	400	8.80	1,000	10.10	1,930	11.80	4,050
7.60	430	8.90	1,060	10.20	2,030	12.00	4,310
7.70	465	9.00	1,120	10.30	2,140		

The preceding table is applicable only for open-channel conditions. It is based upon 8 discharge measurements made during 1904. It is well defined between gage heights 7.00 feet and 9.70 feet. The table has been extended beyond these limits. Above gage height 10.60 feet the rating curve is a tangent, the difference being 130 per tenth.

Estimated monthly discharge of Tieton River near North Yakima, Wash., for 1904.

[Drainage area, 289 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	500	308	360	22,140	1.25	1.44
February	330	258	293	16,850	1.01	1.09
March	447	277	337	20,720	1.17	1.35
April	3,140	330	1,582	94,140	5.47	6.10
May	2,880	1,030	1,614	99,240	5.58	6.43
June	2,195	1,000	1,456	86,640	5.04	5.62
July	1,670	540	961	59,090	3.33	3.84
August	602	353	458	28,160	1.58	1.82
September	388	287	329	19,580	1.14	1.27
October	500	233	278	17,090	.962	1.11
November	1,210	220	413	24,580	1.43	1.60
December	540	287	357	21,950	1.24	1.43
The year	3,140	220	703	510,200	2.43	33.10

ATANUM CREEK NEAR YAKIMA, WASH.

This station was established May 11, 1904, by G. H. Bliss, for the purpose of studying the flow of the creek during the irrigating season. It is located at the Northern Pacific Railway Company's bridge, about 1 mile southeast of Yakima, Wash., 50 feet to the left of the road leading to the Yakima Indian Reservation. The station is three-fourths mile north of the gaging station on Yakima River at Union Gap. A plain staff gage, graduated to feet and tenths, is driven vertically into the bed of the creek and braced to the banks. It is read once each day by Hugh Kennedy. Discharge measurements are made from the downstream side of the railway bridge. The initial point for soundings is the face of the concrete abutment at the right bank. It is marked zero, and 5-foot intervals are marked across the bridge. The channel is straight for 50 feet above and below the station. The current is swift at high, and sluggish at low stages. The right bank is of medium height, clean, and not liable to overflow except at extremely high stages. The left bank is low, clean, and liable to overflow. The bed of the stream is composed of mud, free from vegetation, and not liable to change. There is but one channel

at all stages, broken by one pier. The bench mark is a point on the upstream edge of the top of the center pier of the railway bridge. Its elevation is 11.85 feet above the zero of the gage. The station was discontinued November 30, 1904.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Atanum Creek near Yakima, Wash., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 26	G. H. Bliss	127	4.45	6.63	565
July 1	J. C. Dry	47	3.08	4.90	145
July 18	do	38	2.22	4.40	84
August 11	do	18.2	.80	3.40	14.5
August 19	do	14.9	.73	3.38	10.9

Mean daily gage height, in feet, of Atanum Creek near Yakima, Wash., in 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	6.3	4.9	3.7	3.3	3.0	3.2
2	.....	6.3	4.9	3.6	3.3	3.0	3.2
3	.....	6.1	4.9	3.6	3.3	3.0	3.2
4	.....	6.0	4.9	3.6	3.3	3.0	3.2
5	.....	6.1	5.0	3.6	3.3	3.0	3.2
6	.....	6.0	5.0	3.6	3.3	3.0	3.2
7	.....	6.0	5.0	3.6	3.3	3.0	3.2
8	.....	6.0	4.9	3.6	3.3	3.0	3.3
9	.....	6.0	4.9	3.6	3.0	3.0	3.3
10	.....	5.9	4.9	3.6	3.0	3.0	3.3
11	5.3	5.9	4.7	3.5	3.0	3.2	3.3
12	5.4	5.9	4.5	3.5	3.0	3.2	3.3
13	5.5	5.6	4.5	3.5	3.0	3.1	3.3
14	5.5	5.6	4.4	3.5	3.0	3.1	3.3
15	5.6	5.5	4.3	3.5	3.0	3.1	3.3
16	5.8	5.7	4.3	3.5	3.0	3.1	3.3
17	5.8	5.6	4.3	3.5	3.0	3.1	3.3
18	5.7	5.9	4.3	3.5	3.0	3.1	3.3
19	5.7	5.8	4.3	3.4	3.0	3.1	3.4
20	5.8	5.9	4.2	3.4	3.0	3.2	3.4
21	5.9	5.9	4.2	3.4	3.0	3.2	3.6
22	6.0	5.9	4.0	3.4	3.0	3.2	3.8
23	6.5	5.9	3.9	3.4	3.0	3.1	3.8
24	6.5	5.9	3.9	3.4	3.0	3.3	3.8
25	6.5	5.8	3.9	3.4	3.0	3.3	3.7
26	6.5	5.4	3.9	3.4	3.0	3.3	3.7
27	6.3	5.2	3.9	3.4	3.0	3.3	3.7
28	6.1	5.2	3.9	3.4	3.0	3.2	3.7
29	6.2	5.2	3.9	3.4	3.0	3.2	3.7
30	6.2	5.2	3.7	3.3	3.0	3.2	3.7
31	6.3	.....	3.7	3.3	.....	3.2	.....

NOTE.—Observations were made during irrigating season only.

Rating table for Atanum Creek near Yakima, Wash., from May 11 to November 30, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.00	0	4.10	58	5.10	176	6.10	425
3.10	2	4.20	66	5.20	196	6.20	451
3.20	6	4.30	74	5.30	218	6.30	477
3.30	10	4.40	83	5.40	243	6.40	503
3.40	14	4.50	93	5.50	269	6.50	529
3.50	18	4.60	104	5.60	295	6.60	555
3.60	23	4.70	116	5.70	321	6.70	581
3.70	29	4.80	128	5.80	347	6.80	607
3.80	35	4.90	142	5.90	373	6.90	633
3.90	42	5.00	158	6.00	399	7.00	659
4.00	50						

The above table is applicable only for open-channel conditions. It is based upon 5 discharge measurements taken during 1904. It is well defined between gage heights 3.40 feet and 6.60 feet. The table has been extended beyond these limits. Above gage height 5.40 feet the rating curve is a tangent, the difference being 26 per tenth.

Estimated monthly discharge of Atanum Creek near Yakima, Wash., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
May 11–31	530	220	389	16,200
June	480	200	346	20,580
July	160	30	87.8	5,399
August	30	10	19.4	1,193
September	10	0	2.7	161
October	10	0	3.6	214
November	35	6	14.9	887
The period				44,630

CANALS IN THE YAKIMA RIVER VALLEY, WASHINGTON.

Nowhere in the State of Washington has irrigation been practiced longer or have matters pertaining to irrigation reached a higher state of development than in the Yakima Valley. The rapid fall of the rivers, the great fertility of the soil, and the climatic conditions have all served to bring this about.

The chief sources of water supply for canals used for irrigation are the Yakima and Naches rivers, the latter of which, when it joins the

Yakima, has already received the water of the Tieton. Besides these rivers the Wenas, Cowiche, Atanum, Toppenish, and Satus creeks, and some small creeks in the vicinity of Ellensburg, irrigate large areas of land lying in the valleys through which they flow. From these sources there are about 125,000 acres of land at present under irrigation, and with the available storage reservoirs at the head of the Yakima, Naches, and Tieton rivers, and with economy in the use of the water, it is probable that 300,000 additional acres of land could be irrigated.

There are at the present time about 50 irrigating canals in operation in the Yakima Valley, which obtain their water from the sources above mentioned, and irrigate the low land lying near the streams. This land is of volcanic origin, and very fertile. When water is applied, large and very profitable crops of fruit, hay, hops, and grain are raised.

There remains at the present time a large area of the best quality of land in the Yakima Valley unirrigated, but the available water supply, especially at the low stages of the streams, is practically exhausted, so that the irrigation of additional land is dependent upon stored water, to be used during about two and one-half months of the irrigating season.

There are five reservoir sites available for the storage of water in the Yakima region. These are Lake Clealum, Lake Kachess, and Lake Keechelus, at the head of Yakima River, Bumping Lake, at the head of Naches River, and McAlisters Meadows, on Tieton River.

The canals at present in operation in the Yakima Valley are mostly in the hands of stock companies, which, with but few exceptions, furnish the farmers under the canal water enough to supply all demands. Most farmers have taken from the ditches what water seemed most convenient for their use, which in many instances has been far in excess of the amount actually needed to irrigate their land economically and profitably. The results of this excessive use of water are only too apparent to those who have traveled through the oldest irrigated sections of the Yakima Valley. Land that was once valuable is now water-logged and worthless, alkali being everywhere visible.

The contracts of the best managed canals in the Yakima Valley allow 1 second-foot for 100 and 160 acres of land, which gives a total depth of water of 44 and 27 inches, respectively, over the land irrigated. From the figures which follow, it can be seen that nearly twice this amount was used during the season of 1904.

To determine more accurately the hydrographic conditions existing in the Yakima Valley, a systematic series of investigations were made during the irrigation season of 1904 under the direction of T. A. Noble,

district engineer, by G. H. Bliss, assisted by G. F. Harley. Not only were the former gaging stations on the Yakima, Naches, and Tieton rivers continued, but new stations were established at other controlling points on these rivers, and also upon all but the smallest canals taking water from them. In each case discharge measurements and daily gage readings were taken near the head works of the canals.

As a rule the irrigation season in the Yakima Valley opens about April 16 and closes about October 15, and estimates of discharge have been made for this period. In the tables of monthly discharge the flow for periods during which no gage readings were taken has been estimated. The maximum, minimum, and mean discharges are computed for periods during which water was actually flowing in the canal, the days when the water was shut off as noted in the table of gage heights not being considered. The "total in acre-feet" represents the entire discharge of the canal for the same periods. The figures for "depth in inches over the irrigated area" are computed from the run-off in acre-feet and no allowances are made for losses from waste or other causes. For a list of the canals, see table on page 165 et seq.

CASCADE CANAL NEAR THORP, WASH.

This is the first canal taking water from Yakima River. It heads in the river on its left bank in sec. 33, T. 19 N., R. 17 E., and has just been completed. Owing to the lateness of its completion no land was irrigated from it during the season of 1904. The canal is controlled by a cooperative association.

WEST KITTITAS CANAL NEAR THORP, WASH.

This canal heads in Yakima River on its right bank in sec. 33, T. 19 N., R. 17 E., about 3 miles northwest of Thorp. It is controlled by the West Kittitas Irrigation Company, a cooperative association.

Discharge measurements of West Kittitas canal near Thorp, Wash., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
June 17	Geo. F. Harley	25.8	2.07	1.91	53.5
September 23	do	20.5	1.77	1.48	36.3
September 23	do	18.4	1.78	1.32	32.5
September 23	do	.0	.00	.00	.0

NOTE.—Measured in a 14-foot flume.

Mean daily gage height, in feet, of West Kittitas canal near Thorp, Wash., for 1904.

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	June.	July.	Aug.	Sept.	Oct.
1	.....	(a)	1.58	2.33	2.00	17	1.92	1.75	1.92	.....	.....
2	.....	(a)	(a)	2.29	2.00	18	1.96	1.67	1.79	.....	.....
3	.....	(a)	(a)	2.25	.....	19	2.00	1.62	1.58	.....	.....
4	.....	1.67	2.04	2.17	.....	20	1.96	1.54	1.54	.....	.....
5	.....	1.83	2.04	2.17	.....	21	1.87	1.46	1.50	.....	.....
6	.....	1.83	1.96	2.17	.....	22	1.96	1.37	1.50	.....	.....
7	.....	1.67	1.92	(b)	.....	23	1.96	1.96	1.42	1.75	.....
8	.....	1.96	1.87	.....	.....	24	1.83	1.92	1.37	1.75	.....
9	.....	1.83	1.87	.....	.....	25	1.79	1.83	2.00	1.71	.....
10	.....	2.21	1.87	.....	.....	26	(a)	1.33	2.17	1.71	.....
11	.....	2.21	1.83	.....	.....	27	(a)	(a)	2.25	1.71	.....
12	.....	2.17	2.00	.....	.....	28	(a)	(a)	2.37	1.75	.....
13	.....	2.12	1.92	.....	.....	29	(a)	1.83	2.37	1.87	.....
14	.....	2.00	1.92	.....	.....	30	(a)	1.83	2.42	1.96	.....
15	.....	2.00	2.00	.....	.....	31	.....	1.67	2.42	.....	.....
16	.....	1.83	1.96	.....	.....						

a Water shut off.
b No record.

Rating table for West Kittitas canal near Thorp, Wash., from June 17 to October 2, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.00	0.0	0.65	9.9	1.30	30.5	1.95	53.9
.05	.5	.70	11.0	1.35	32.3	2.00	55.7
.10	1.1	.75	12.2	1.40	34.1	2.05	57.5
.15	1.7	.80	13.5	1.45	35.9	2.10	59.3
.20	2.3	.85	14.9	1.50	37.7	2.15	61.1
.25	3.0	.90	16.4	1.55	39.5	2.20	62.9
.30	3.7	.95	18.0	1.60	41.3	2.25	64.7
.35	4.5	1.00	19.7	1.65	43.1	2.30	66.5
.40	5.3	1.05	21.5	1.70	44.9	2.35	68.3
.45	6.1	1.10	23.3	1.75	46.7	2.40	70.1
.50	7.0	1.15	25.1	1.80	48.5	2.45	71.9
.55	7.9	1.20	26.9	1.85	50.3	2.50	73.7
.60	8.9	1.25	28.7	1.90	52.1		

The above table is based upon 4 discharge measurements made during 1904. It is not well defined. Above gage height 1.00 foot the rating curve is a tangent, the difference being 3.6 per tenth.

Mean daily discharge, in second-feet, of West Kittitas canal near Thorp, Wash., for 1904.

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	June.	July.	Aug.	Sept.	Oct.
1		(a)	41	68	56	17	52	47	52		
2		(a)	(a)	67	56	18	54	43	49		
3		(a)	(a)	65		19	56	41	41		
4		43	58	61		20	54	40	40		
5		50	58	61		21	50	36	38		
6		50	54	61		22	54	32	38		
7		43	52			23	54	54	34	47	
8		54	50			24	50	52	32	47	
9		50	50			25	49	50	56	45	
10		63	50			26	(a)	32	61	45	
11		63	50			27	(a)	(a)	65	45	
12		61	56			28	(a)	(a)	68	47	
13		59	52			29	(a)	50	68	50	
14		56	52			30	(a)	50	70	54	
15		56	56			31	(a)	43	70		
16		50	54								

a Water shut off.

Estimated monthly discharge of West Kittitas canal near Thorp, Wash., for 1904.

[Irrigated area, 7,000 acres.]

Month.	Discharge in second-feet.			Total in acre-feet.	Depth of run-off in inches, over irrigated area.
	Maximum.	Minimum.	Mean.		
April 16–30[a]			50	1,488	2.54
May[a]			50	3,074	5.27
June[a b]			53	2,628	4.50
July[b]	63	32	48.8	2,517	4.30
August[c]	70	32	52.2	3,003	5.14
September[d]	68	45	55	3,273	5.60
October 1–15			56	1,666	2.85
The period	70	32	52	17,650	30.20

a Estimated.
b Water shut off 5 days.
c Water shut off 2 days.
d September 7–22 estimated.

TOWN CANAL NEAR ELLENSBURG, WASH.

This canal heads in the left bank of Yakima River about 9 miles northwest of Ellensburg, in sec. 7, T. 18 N., R. 18 E. The discharge was gaged June 16 and again August 5. About July 10 the canal was cleaned and considerable material which had been washed in was removed. On account of these changes of the channel the estimates of discharge are only approximate. The canal is controlled by a cooperative association.

Discharge measurements of Town canal near Ellensburg, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
June 16	G. F. Harley	20	61.2	2.06	4.15	126
August 5	do	20	58.3	2.19	3.75	128

Mean daily gage height, in feet, of Town canal near Ellensburg, Wash., for 1904.

Day.	June.	July.	Aug.	Sept.	Day.	June.	July.	Aug.	Sept.
1		4.08	3.67	3.75	17	4.17	3.83	3.83	3.50
2		4.08	3.67	3.67	18	4.17	3.83	3.83	3.46
3		4.08	3.67	3.71	19	4.25	3.67	3.83	3.46
4		4.08	3.67	3.67	20	(a)	3.67	3.92	3.42
5		4.08	3.75	3.67	21	(a)	3.67	3.92	
6		4.08	3.75	3.67	22	4.00	3.67	3.92	
7		4.08	3.75	3.71	23	4.00	3.67	3.92	
8		4.33	3.71	3.62	24	3.92	3.67	3.92	
9		4.33	3.71	3.62	25	4.08	3.67	3.83	
10		(a)	3.67	3.58	26	4.08	3.67	3.83	
11		(a)	3.67	3.58	27	4.08	3.75	3.83	
12		(a)	3.58	3.54	28	4.08	3.75	3.83	
13		(a)	3.58	3.50	29	4.08	3.75	3.83	
14		(a)	3.67	3.50	30	4.08	3.67	3.75	
15		(a)	3.67	3.50	31		3.67	3.75	
16	4.17	3.92	3.75	3.50					

a Water shut off.

Mean daily discharge, in second-feet, of Town canal near Ellensburg, Wash., for 1904.

Day.	June.	July.	Aug.	Sept.	Day.	June.	July.	Aug.	Sept.
1		122	120	128	17	126	132	132	112
2		122	120	120	18	126	132	132	110
3		122	120	127	19	129	120	132	110
4		122	120	120	20	(a)	120	136	108
5		122	128	120	21	(a)	120	136	
6		122	128	120	22	119	120	136	
7		122	128	127	23	119	120	136	
8		134	127	117	24	114	120	136	
9		134	127	117	25	122	120	132	
10		(a)	120	114	26	122	120	132	
11		(a)	120	114	27	122	128	132	
12		(a)	114	113	28	122	128	132	
13		(a)	114	112	29	122	128	132	
14		(a)	120	112	30	122	120	128	
15		(a)	120	112	31		120	128	
16	126	135	128	112					

a Water shut off.

Estimated monthly discharge of Town canal near Ellensburg, Wash., for 1904.

[Irrigated area, 8,000 acres.]

Month.	Discharge in second-feet.			Total in acre-feet.	Depth of run-off in inches over irrigated area.
	Maximum.	Minimum.	Mean.		
April 16–31 [a]			100	2,975	4.46
May			110	6,764	10.2
June [b]	129	114	122	6,776	10.2
July [c]	135	120	124	6,150	9.23
August	136	114	127	7,809	11.7
September [a]	128	108	116	6,902	10.4
October 1–15 [d]			100	2,975	4.46
The period	136	108	116	40,350	60.6

[a] Estimated.
[b] Water shut off 2 days; estimated June 1–15.
[c] Water shut off 6 days.
[d] Estimated September 21–30.

OLSEN (OR MILL) DITCH NEAR ELLENSBURG, WASH.

This ditch heads in the left bank of Yakima River just below Town canal. It has under it about 1,200 acres of land, nearly all cultivated. A miscellaneous measurement taken August 5 gave a discharge of 14 second-feet.

SELAH-MOXEE CANAL NEAR NORTH YAKIMA, WASH.

This canal heads in the left bank of Yakima River just below the Yakima Canyon in sec. 8, T. 14 N., R. 19 E. It is the next canal of importance below the Olsen (or Mill) ditch at Ellensburg. Measurements taken on the wasteways of the Selah-Moxee canal show that its direct waste into the river rarely exceeds 25 per cent of the water taken in at the headworks and often is practically nothing.

Discharge measurements of Selah-Moxee canal near North Yakima, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 26	G. H. Bliss	22	41	2.46	2.42	84
June 8	do	19	40	1.70	2.17	[a] 68
June 22	do	23	52	1.92	2.50	[b] 99
June 30	J. C. Dry	20	45	1.71	2.25	77
September 21	G. H. Bliss	19	37	1.37	([c])	51

[a] 10 second-feet wasting.
[b] 40 second-feet wasting.
[c] Measured below wasteway No 2.

Mean daily gage height, in feet, of Selah-Moxee canal near North Yakima, Wash., for 1904.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	2.83	2.29	2.37	2.29	2.33	1.42
2	.....	2.58	2.25	2.37	2.21	2.33	1.42
3	.....	2.42	2.25	2.37	2.29	2.29	1.42
4	.....	2.33	2.25	2.37	2.37	2.29	1.42
5	.....	2.17	2.29	2.00	2.21	2.29	1.42
6	.....	2.08	2.37	2.29	2.25	2.29	1.42
7	.....	2.08	2.42	2.29	2.21	2.29	1.25
8	.....	1.79	2.17	2.21	2.17	2.33	.....
9	.....	1.58	2.04	2.21	2.21	2.33	.....
10	.....	1.42	1.04	2.12	2.29	2.33	.....
11	.....	2.21	2.21	2.04	2.17	2.33	.....
12	.....	2.21	2.29	2.00	2.29	2.33	.....
13	.....	2.21	2.21	2.04	2.29	2.33	.....
14	.....	2.25	2.08	2.12	2.25	2.33	.....
15	.....	2.29	2.08	2.00	2.29	2.33	.....
16	.....	2.29	2.33	1.92	2.29	2.29	.....
17	.....	2.25	2.25	2.00	2.29	2.29	.....
18	.....	2.21	2.37	2.00	2.29	2.25	.....
19	.....	2.25	2.42	2.04	2.29	2.25	.....
20	.....	2.25	2.46	2.17	2.29	2.25	.....
21	.....	2.29	2.46	2.12	2.29	2.25	.....
22	.....	2.46	2.50	2.12	2.29	2.25	.....
23	.....	2.46	2.37	2.12	2.37	2.25	.....
24	.....	2.42	2.37	2.21	2.37	2.17	.....
25	.....	2.33	2.25	2.21	2.32	2.17	.....
26	2.42	2.29	2.17	2.12	2.25	1.79	.....
27	2.00	2.25	2.08	2.21	2.29	1.42	.....
28	2.58	2.25	2.25	2.12	2.29	1.42	.....
29	2.67	2.33	2.29	2.21	2.33	1.42	.....
30	2.75	2.33	2.25	2.12	2.42	1.42	.....
31	.....	2.33	.....	2.12	2.33	.....	.....

Mean daily discharge, in second-feet, of Selah-Moxee canal near North Yakima, Wash., for 1904.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	132	78	86	78	83	40
2	.....	107	75	86	73	83	40
3	.....	91	75	86	78	78	40
4	.....	81	75	86	86	78	40
5	.....	70	78	60	73	78	40
6	.....	65	86	78	75	78	40
7	.....	65	91	78	73	78	36
8	.....	52	68	73	70	83	.....
9	.....	46	62	73	73	83	.....
10	.....	40	31	67	78	83	.....
11	.....	73	73	63	70	83	.....
12	.....	73	78	60	78	83	.....
13	.....	73	73	63	78	83	.....
14	.....	75	65	67	75	83	.....
15	.....	78	65	60	78	83	.....
16	.....	78	82	57	78	78	.....
17	.....	75	75	60	78	78	.....
18	.....	73	86	60	78	75	.....
19	.....	75	91	63	78	75	.....

Mean daily discharge, in second-feet, of Selah-Moxee canal near North Yakima, Wash., for 1904—Continued.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
20	.....	75	95	70	78	75	.....
21	.....	78	96	67	78	75	.....
22	.....	95	99	67	78	75	.....
23	.....	95	86	67	86	75	.....
24	.....	91	86	72	86	70	.....
25	.....	82	75	72	83	70	.....
26	84	78	68	67	75	52	.....
27	60	75	65	73	78	40	.....
28	107	75	75	67	78	40	.....
29	116	82	78	73	83	40	.....
30	124	82	77	67	91	40	.....
31	.....	82	.....	67	83	.....	.....

Rating table for Selah-Moxee canal near North Yakima, Wash., from April 26 to October 7, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.35	39	1.80	52	2.20	72	2.60	109
1.40	40	1.85	54	2.25	75	2.65	114
1.45	41	1.90	56	2.30	79	2.70	119
1.50	42	1.95	58	2.35	84	2.75	124
1.55	43	2.00	60	2.40	89	2.80	129
1.60	44	2.05	63	2.45	94	2.85	134
1.65	46	2.10	66	2.50	99	2.90	139
1.70	48	2.15	69	2.55	104	2.95	144
1.75	50						

The above table is based upon five discharge measurements made during 1904. Above gage height 2.25 the table is well defined.

Estimated monthly discharge of Selah-Moxee canal near North Yakima, Wash., for 1904.

[Irrigated area, 6,000 acres.]

Month.	Discharge in second-feet.			Total in acre-feet.	Depth of run-off in inches over irrigated area.
	Maximum.	Minimum.	Mean.		
April 16–30 [a]	.....	.....	98.0	2,916	5.83
May	132	40	77.8	4,784	9.57
June	99	31	76.9	4,576	9.15
July	86	57	69.5	4,273	8.55
August	91	70	78.2	4,808	9.62
September	83	40	72.6	4,320	8.64
October 1–15 [b]	.....	.....	39.0	1,160	2.32
The period	132	31	74.9	26,840	53.7

[a] Estimated April 16–25.

[b] Estimated October 8–15.

TAYLOR CANAL NEAR NORTH YAKIMA, WASH.

This is the next canal taking water from the Yakima below the Selah-Moxee canal. It heads in the right bank about 4 miles above the mouth of Naches River. The canal was built by the original owners of the adjacent land, and as they have disposed of their land they have included in the sale a water right which is understood to be 1 miner's inch per acre, though there is no accurate system of measuring the water used. Maintenance is carried on by assessments.

No station has been maintained on this canal. Two measurements were taken just below the headworks with the following results:

	Sec.-feet.
August 9, discharge	9
September 19, discharge	13

MOXEE AND HUBBARD CANALS NEAR NORTH YAKIMA, WASH.

The Moxee Company controls and operates these canals. They head in the Yakima River near the line between secs. 7 and 18 in T. 13 N., R. 19 E. Gaging stations were maintained on each canal, but the table of estimated monthly discharge is computed for the combined flow and the area irrigated by both canals. Very little water is wasted directly into the river by either of these canals.

Discharge measurements of Moxee canal near North Yakima, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square ft.*	*Ft. per sec.*	*Feet.*	*Second-ft.*
May 20	G. H. Bliss	9	10.8	1.39	1.17	15
June 17	do	9	9.9	.91	1.08	9
September 3	J. C. Dry	9	15.0	.80	1.54	12

Mean daily gage height, in feet, of Moxee canal near North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1		1.37	1.14	1.33	1.58	1.04
2		1.37	(a)	1.44	1.58	1.06
3		1.37	(a)	1.37	1.54	.62
4		1.39	.83	1.37	1.54	.69
5		1.35	.81	(a)	1.62	.....
6		1.39	.92	(a)	1.50	.....
7		1.33	.94	1.44	1.54	.....
8		1.37	.92	1.50	1.54	.....
9		1.35	.92	1.46	1.56	.....
10		1.46	.95	1.53	1.50	.....
11		1.45	.92	1.46	1.49	.....
12		1.42	.90	1.53	1.50	.....
13		1.17	.88	1.56	1.46	.....
14		1.19	.98	1.50	1.46	.....

a Water shut off.

Mean daily gage height, in feet, of Moxee canal near North Yakima, Wash., for 1904—Cont'd.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
15	.....	1.06	1.14	1.48	1.45	.....
16	.....	1.07	.85	1.52	1.44	.....
17	.....	1.08	.91	1.54	1.44	.....
18	.....	1.12	.96	1.54	1.39	.....
19	.....	1.11	1.12	1.54	1.39	.....
20	1.17	1.09	1.15	1.60	1.39	.....
21	1.12	1.08	1.29	1.57	1.42	.....
22	1.21	1.04	1.36	1.56	1.50	.....
23	1.15	1.02	1.29	1.56	1.58	.....
24	1.17	.96	1.19	1.58	1.60	.....
25	1.21	1.17	1.17	1.67	1.25	.....
26	1.15	1.21	1.43	1.61	1.06	.....
27	1.29	1.17	1.35	1.65	1.04	.....
28	1.27	1.21	1.29	1.67	1.08	.....
29	1.29	1.23	1.27	1.74	1.08	.....
30	1.29	1.21	1.27	1.58	1.04	.....
31	1.23	.....	1.27	1.52	.....	.....

Mean daily discharge, in second-feet, of Moxee canal near North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	28	13	25	40	6
2	.....	28	(a)	33	40	7
3	.....	28	(a)	28	39	1
4	.....	29	1	28	39	1
5	.....	26	1	(a)	42	.....
6	.....	29	2	(a)	36	.....
7	.....	25	2	33	39	.....
8	.....	28	2	36	39	.....
9	.....	26	2	33	39	.....
10	.....	33	3	38	39	.....
11	.....	33	2	33	34	.....
12	.....	31	2	38	36	.....
13	.....	15	1	39	34	.....
14	.....	16	4	36	34	.....
15	.....	7	12	34	33	.....
16	.....	8	1	37	32	.....
17	.....	9	2	39	32	.....
18	.....	11	2	39	29	.....
19	.....	10	12	39	29	.....
20	15	9	13	42	29	.....
21	11	8	23	40	32	.....
22	17	6	26	39	36	.....
23	13	5	23	39	40	.....
24	15	1	16	40	42	.....
25	17	15	15	47	20	.....
26	13	16	33	42	7	.....
27	23	15	26	45	6	.....
28	22	17	23	47	9	.....
29	23	19	22	51	9	.....
30	23	17	22	39	6	.....
31	19	.....	22	37	.....	.....

a Water shut off.

Discharge measurements of Hubbard canal near North Yakima, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 20	G. H. Bliss	12	20.0	1.50	1.92	30
June 17	do	12	17.6	1.14	1.66	20
June 17	do	12	14.5	1.17	1.42	17
September 3	J. C. Dry	12	18.5	1.29	1.78	24

Mean daily gage height, in feet, of Hubbard canal near North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1		1.96	1.96	1.71	1.79	1.14
2		1.94	2.12	2.02	1.79	1.14
3		1.95	2.12	2.00	1.77	1.17
4		1.95	1.74	1.95	1.73	1.15
5		1.96	1.72	1.83	1.75	
6		1.95	1.71	1.81	1.62	
7		1.99	1.69	1.75	1.62	
8		1.92	1.26	1.79	1.60	
9		1.86	1.25	2.12	1.69	
10		1.95	1.24	2.03	1.69	
11		1.85	1.23	1.96	1.68	
12		1.62	1.21	1.85	1.67	
13		1.59	1.31	1.85	1.67	
14		1.67	1.20	1.78	1.67	
15		1.73	1.10	1.73	1.67	
16		1.74	1.62	2.14	1.67	
17		1.42	1.62	2.10	1.67	
18		1.42	1.79	2.10	1.62	
19		1.42	1.60	2.10	1.62	
20	1.92	1.39	1.71	2.12	1.33	
21	1.79	1.39	1.83	2.11	1.33	
22	1.85	1.95	1.87	1.98	1.33	
23	1.78	1.79	1.77	1.94	1.42	
24	1.79	1.04	1.62	1.87	1.42	
25	1.88	1.04	1.50	1.79	1.14	
26	1.79	1.77	1.98	1.73	1.14	
27	2.06	1.79	2.00	1.89	1.12	
28	2.05	1.81	2.00	1.92	1.12	
29	2.05	1.79	1.95	2.04	1.12	
30	2.05	1.79	1.87	1.83	1.14	
31	2.04		1.87	1.79		

Mean daily discharge, in second-feet, of Hubbard canal near North Yakima, Wash., for 1904.

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	May.	June.	July.	Aug.	Sept.
1	31	31	21	24	15	17	.....	17	19	42	20
2	31	42	34	24	15	18	.....	17	24	42	19
3	31	42	34	23	15	19	.....	17	19	42	19
4	31	23	31	23	15	20	28	17	21	42	16
5	31	21	26	23	.....	21	24	17	26	42	16
6	31	21	24	19	.....	22	26	31	26	34	16
7	34	21	23	19	.....	23	24	24	23	31	17
8	28	16	24	19	.....	24	24	15	19	26	17
9	26	16	42	21	.....	25	28	15	18	24	15
10	31	16	31	21	.....	26	24	23	34	23	15
11	26	16	31	21	.....	27	38	24	34	28	15
12	19	16	26	20	.....	28	38	24	34	28	15
13	19	16	26	20	.....	29	38	24	31	38	15
14	20	16	23	20	.....	30	38	24	26	26	15
15	23	15	23	20	.....	31	38	.....	26	24	.....
16	23	19	47	20	.....						

Rating table for Hubbard canal near North Yakima, Wash., from May 20 to October 4, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.00	14.9	1.35	16.3	1.65	20.2	1.95	31
1.05	15.0	1.40	16.8	1.70	21.2	2.00	34
1.10	15.1	1.45	17.3	1.75	22.6	2.05	38
1.15	15.3	1.50	17.8	1.80	24.2	2.10	42
1.20	15.5	1.55	18.4	1.85	26.0	2.15	47
1.25	15.7	1.60	19.2	1.90	28.2	2.20	53
1.30	16.0						

The above table is based upon four discharge measurements made during 1904. Above gage height 1.40 it is well defined.

Estimated monthly discharge of Moxee and Hubbard canals near North Yakima, Wash., for 1904.

[Irrigated area, 3,500 acres.]

Month.	Discharge in second-feet.			Total in acre-feet.	Depth of run-off in inches over irrigated area.
	Maximum.	Minimum.	Mean.		
April 16–30 [a]	.....	.....	35.0	1,041	3.57
May	61	35	49.0	3,013	10.3
June	67	16	42.4	2,523	8.64
July	68	16	33.8	2,078	7.12
August	98	46	72.8	4,476	15.4
September	66	21	49.6	2,951	10.1
October 1–15	.....	.....	19	568	1.95
The period	98	16	45.9	16,650	57.1

[a] Estimated April 16 to May 19; also October 5–15.

FOWLER CANAL NEAR NORTH YAKIMA, WASH.

This canal heads in Yakima River, in sec. 18, T. 13 N., R. 19 E. It is controlled by a stock company.

Discharge measurements of Fowler canal near North Yakima, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 20	G. H. Bliss	10	14.7	2.38	1.24	35.0
June 17	do	10	9.8	1.86	.75	18.2
September 3	J. C. Dry	10	13.7	2.18	1.20	29.1
September 3	do				.00	Dry.

Mean daily gage height, in feet, of Fowler canal near North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1		1.10	1.04	0.82	1.21	0.79
2		1.08	1.09	.89	1.19	.00
3		1.09	1.10	.81	1.17	.33
4		1.11	1.17	.71	1.17	.73
5		1.10	1.14	.85	1.17	
6		1.15	1.08	.83	1.21	
7		1.01	1.04	.60	1.21	
8		.98	1.04	.64	1.19	
9		.92	.92	1.00	1.29	
10		1.02	.88	1.00	1.33	
11		1.00	1.10	.96	1.31	
12		.98	1.04	.92	1.31	
13		.92	.71	.92	1.25	
14		.95	.54	.85	1.25	
15		1.00	.46	.92	1.24	
16		1.07	1.08	.92	1.21	
17		.78	1.04	.83	1.21	
18		.52	.92	.85	1.17	
19		.52	.83	.81	1.17	
20	1.24	.50	.88	1.06	1.21	
21	1.25	.50	.88	1.06	1.25	
22	1.32	.44	.88	1.04	1.25	
23	1.15	.65	.83	1.02	1.27	
24	1.14	.67	.75	1.00	1.27	
25	1.03	.69	.56	.98	1.29	
26	1.33	.62	1.00	.98	1.29	
27	1.21	.87	1.00	1.08	1.29	
28	1.20	1.00	.94	.0	.0	
29	1.21	.92	.89	.77	.0	
30	1.21	1.04	.82	1.21	.0	
31	1.19		.88	.0		

Mean daily discharge, in second-feet, of Fowler canal near North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	29	27	20	32	20
2	.....	29	29	23	32	0
3	.....	29	29	20	30	7
4	.....	29	30	17	30	18
5	.....	29	30	21	30	.....
6	.....	30	29	21	32	.....
7	.....	26	27	14	32	.....
8	.....	26	27	15	32	.....
9	.....	23	23	26	35	.....
10	.....	26	23	26	37	.....
11	.....	26	29	24	35	.....
12	.....	26	27	23	35	.....
13	.....	23	17	23	34	.....
14	.....	24	12	21	34	.....
15	.....	26	10	23	34	.....
16	.....	27	29	23	32	.....
17	.....	20	27	21	32	.....
18	.....	11	23	21	30	.....
19	.....	11	21	20	30	.....
20	34	11	23	27	32	.....
21	34	11	23	27	34	.....
22	35	10	23	27	34	.....
23	30	15	21	26	34	.....
24	30	15	18	26	34	.....
25	27	17	12	26	35	.....
26	37	14	26	26	35	.....
27	32	21	26	29	35	.....
28	32	26	24	0	0	.....
29	32	23	23	20	0	.....
30	32	27	20	32	0	.....
31	32	.....	23	0	.....	.....

Rating table for Fowler canal near North Yakima, Wash., from May 20 to October 4, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.30	6.0	0.60	13.7	0.90	22.5	1.15	30.3
.35	7.2	.65	15.1	.95	24.0	1.20	31.9
.40	8.4	.70	16.5	1.00	25.5	1.25	33.5
.45	9.7	.75	18.0	1.05	27.1	1.30	35.1
.50	11.0	.80	19.5	1.10	28.7	1.35	36.7
.55	12.3	.85	21.0				

The above table is based upon 4 discharge measurements made during 1904. It is not well defined.

Estimated monthly discharge of Fowler canal near North Yakima, Wash., for 1904.

[Irrigated area, 2,000 acres.]

Month.	Discharge in second-feet.			Total in acre-feet.	Depth of run-off, in inches, over irrigated area.
	Maximum.	Minimum.	Mean.		
April 16–30 [a]			25.0	744	4.46
May	37	27	34.0	2,091	12.6
June	30	10	22.0	1,309	7.85
July	30	10	23.6	1,451	8.71
August [b]	32	14	23.0	1,323	7.94
September [c]	37	30	33.0	1,767	10.6
October 1–15 [d] [e]			15.0	444	2.66
The period	37	10	25.9	9,129	54.8

[a] Estimated April 16 to May 19.
[b] Water shut off 2 days.
[c] Water shut off 3 days.
[d] Water shut off 1 day.
[e] Estimated October 5–15.

GRANGER CANAL NEAR NORTH YAKIMA, WASH.

This canal heads in Yakima River in sec. 18, T. 13 N., R. 19 E. It is owned and operated by a private party and irrigates a small tract of land in the Moxee Valley. Owing to insufficient measurements no estimates of discharge were made for this canal.

Discharge measurements of Granger canal near North Yakima, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 20	G. H. Bliss	17	11.5	1.6	2.0	[a] 17.7

[a] Backwater in canal.

Mean daily gage height, in feet, of Granger canal near North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1		1.98	2.00	1.44	2.04	1.12
2		1.93	2.23	1.48	2.02	1.12
3		1.94	2.17	1.46	2.00	1.12
4		1.96	2.21	1.42	1.98	1.12
5		1.93	2.19	1.48	1.98	
6		2.01	2.14	1.46	2.02	
7		1.19	2.08	1.39	2.00	
8		1.17	2.12	1.42	2.00	
9		1.11	2.06	1.73	1.17	
10		1.12	2.02	1.71	1.17	
11		1.10	1.46	1.69	1.17	
12		1.10	1.46	2.57	1.14	
13		2.54	1.39	2.60	1.12	
14		2.57	1.35	2.58	1.12	

Mean daily gage height, in feet, of Granger canal near North Yakima, Wash., for 1904—Continued.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
15	.....	2.62	1.35	1.79	1.12	.....
16	.....	2.10	1.42	1.93	1.12	.....
17	.....	2.50	1.36	1.85	1.12	.....
18	.....	2.52	1.37	1.85	1.12	.....
19	.....	2.52	1.35	1.83	1.08	.....
20	2.00	2.52	1.37	1.93	1.08	.....
21	2.00	2.54	1.37	1.87	1.08	.....
22	2.06	2.51	1.87	2.07	1.08	.....
23	1.73	2.48	1.85	2.06	1.10	.....
24	1.75	2.50	1.81	2.01	1.10	.....
25	1.75	2.56	1.81	1.96	1.10	.....
26	2.04	2.52	1.89	1.94	1.10	.....
27	2.00	2.52	1.94	2.00	1.12	.....
28	2.00	2.58	1.89	1.94	1.08	.....
29	2.00	2.02	1.85	2.12	1.12	.....
30	2.00	2.21	1.78	2.21	1.12	.....
31	1.99	.....	1.43	2.10	.....	.....

NEW RESERVATION CANAL NO. 2 IN YAKIMA INDIAN RESERVATION, WASH.

This is the first canal taking water from Yakima River below Atanum Creek. It was built by the Government to irrigate lands in the Yakima Indian Reservation. It heads in the right bank in sec. 17, T. 12 N., R. 19 E. Only about 4½ miles of the main canal had been constructed in 1904. The length of the main canal as proposed will be 65 miles, with three laterals aggregating 25 miles. The gradient is .03 per 100 feet, which causes a wash in some places.

Discharge measurements of New Reservation canal No. 2 in Yakima Indian Reservation, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 9	G. H. Bliss	40	17.5	1.00	0.41	17.7
June 7	do	40	40	1.10	.75	44
June 27	do	40	44	1.25	.95	55
July 22	J. C. Dry	40	54	1.53	1.17	82
August 19	do	40	40	1.30	.83	52

Mean daily gage height, in feet, of New Reservation canal No. 2 in Yakima Indian Reservation, for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Day.	May.	June.	July.	Aug.	Sept.
1	.....	0.62	1.17	1.21	1.17	17	0.58	1.00	1.08	0.87	1.00
2	.....	.67	1.17	1.25	1.17	18	.58	1.00	1.08	.87	1.00
3	.....	.71	1.17	1.21	1.17	19	.67	.50	1.08	.83	1.00
4	.....	.71	1.17	1.29	1.17	20	.58	.83	1.17	.83	1.00
5	.....	.67	1.17	1.00	1.17	21	.67	.92	1.21	.83	1.00
6	.....	.67	1.17	1.29	1.17	22	.62	.92	1.19	.83	1.00
7	.....	.75	1.17	1.17	1.17	23	.75	.92	1.00	.83	.92
8	.....	.83	1.17	1.12	1.17	24	.71	.92	1.17	.83	.92
9	0.40	.75	1.08	1.00	1.17	25	.75	.92	1.17	.83	.92
10	.42	.75	1.08	1.00	1.17	26	.71	.92	1.12	.92	.83
11	.42	.77	1.08	.92	1.17	27	.67	.92	1.08	1.00	.83
12	.42	.75	1.08	.96	1.08	28	.67	.96	1.08	1.17	.83
13	.53	.83	1.08	.83	1.08	29	.67	1.00	1.17	1.50	.75
14	.53	.83	1.08	.92	1.08	30	.67	1.17	1.17	.75	.75
15	.53	1.00	1.08	.83	1.08	31	.67	.....	1.12	(a)	.....
16	.53	1.00	1.08	.75	1.08						

[a] Water shut off.

Mean daily discharge, in second feet, of New Reservation canal No. 2 in Yakima Indian Reservation, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Day.	May.	June.	July.	Aug.	Sept.
1	.....	27	90	97	90	17	27	69	83	49	69
2	.....	30	90	104	90	18	27	69	83	49	69
3	.....	34	90	97	90	19	30	21	83	49	69
4	.....	34	90	121	90	20	27	49	90	49	69
5	.....	30	90	69	90	21	30	55	97	49	69
6	.....	30	90	121	90	22	27	55	97	49	69
7	.....	38	90	90	90	23	38	55	69	49	55
8	.....	49	90	83	90	24	34	55	90	49	55
9	17	38	83	69	90	25	38	55	90	49	55
10	17	38	83	69	90	26	34	55	83	55	49
11	17	38	83	55	90	27	30	55	83	69	49
12	17	38	83	62	83	28	30	62	83	90	49
13	24	49	83	49	83	29	30	69	90	149	38
14	24	49	83	55	83	30	30	90	90	38	38
15	24	69	83	49	83	31	30	.....	83	(a)	.....
16	24	69	83	38	83						

[a] Water shut off.

Rating table for New Reservation canal No. 2 in Yakima Indian Reservation, Wash., from May 9 to September 30, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.15	10	0.50	21	0.85	49	1.20	97
.20	11	.55	24	.90	55	1.25	104
.25	12	.60	27	.95	62	1.30	121
.30	13	.65	30	1.00	69	1.35	128
.35	15	.70	34	1.05	76	1.40	135
.40	17	.75	38	1.10	83	1.45	142
.45	19	.80	43	1.15	90	1.50	149

The above table is based upon 5 discharge measurements made during 1904. It is not well defined.

Estimated monthly discharge of New Reservation canal No. 2 in Yakima Indian Reservation, Wash., for 1904.

[Irrigated area, 2,700 acres.]

Month.	Discharge in second-feet.			Total in acre-feet.	Depth of run-off in inches, over irrigated area.
	Maximum.	Minimum.	Mean.		
April 16–30 [a]			20.0	595	2.64
May	38	17	27.0	1,660	7.38
June	90	21	49.1	2,922	13.0
July	97	63	86.4	5,312	23.6
August [b]	149	38	69.0	4,106	18.2
September	90	38	73.6	4,380	19.5
October 1–15 [c]			50.0	1,488	6.61
The period	149	21	56.4	20,460	90.9

[a] Estimated April 15 to May 8. [b] Water shut off 1 day. [c] Estimated.

OLD RESERVATION CANAL NO. 1 IN YAKIMA INDIAN RESERVATION, WASH.

This canal takes water from Yakima River, on its right bank, in sec. 28, T. 12 N., R. 19 E. It was built by the Government from an Indian fund derived from the sale of the Wenache fishery lands, which formerly belonged to the Indians.

Discharge measurements of Old Reservation canal No. 1 in Yakima Indian Reservation, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 9	G. H. Bliss	12	43	3.00	2.83	130
June 7	do	12	49	3.10	3.17	152
June 27	do	13	51	3.60	3.29	184
July 22	J. C. Dry	12	44	2.91	2.99	127
August 19	do	12	41	2.69	2.83	110

Mean daily gage height, in feet, of Old Reservation canal No. 1 in Yakima Indian Reservation Wash., for 1904.

Day.	June.	July.	Aug.	Day.	June.	July.	Aug.	Day.	June.	July.	Aug.
1	.....	3.37	3.17	12	2.06	3.33	3.08	22	3.17	2.92	3.17
2	.....	3.33	3.25	13	2.06	3.33	3.08	23	3.17	2.96	3.17
3	.....	3.33	3.27	14	2.06	3.29	3.08	24	3.25	2.92	3.17
4	.....	3.35	3.25	15	2.00	3.29	3.04	25	3.25	2.21	3.17
5	.....	3.33	3.29	16	2.07	3.25	3.00	26	3.17	2.21	3.17
6	.....	3.35	3.17	17	2.06	3.25	3.00	27	3.33	2.25	3.17
7	3.17	3.35	3.17	18	3.02	3.17	2.92	28	3.33	2.17	3.17
8	3.00	3.33	3.17	19	3.02	3.21	2.83	29	3.33	2.17	3.17
9	3.00	3.33	3.12	20	3.02	3.12	2.83	30	3.33	2.12	3.17
10	3.00	3.33	3.08	21	3.02	3.00	3.17	31	.....	2.08	3.17
11	3.02	3.33	3.08								

Mean daily discharge, in second-feet, of Old Reservation canal No. 1 in Yakima Indian Reservation, Wash., for 1904.

Day.	June.	July.	Aug.	Day.	June.	July.	Aug.	Day.	June.	July.	Aug.
1	.....	214	152	12	112	200	143	22	152	133	152
2	.....	200	167	13	112	200	143	23	152	136	152
3	.....	200	170	14	112	170	143	24	167	133	152
4	.....	205	167	15	111	170	140	25	167	115	152
5	.....	200	170	16	112	167	139	26	149	115	152
6	.....	205	152	17	112	167	139	27	190	116	152
7	152	205	152	18	138	152	133	28	190	114	152
8	139	200	152	19	138	158	130	29	190	114	152
9	139	200	145	20	138	145	130	30	190	113	152
10	139	200	143	21	138	139	152	31	.....	112	152
11	138	200	143								

Estimated monthly discharge[a] of Old Reservation canal No. 1 in Yakima Indian Reservation, Wash., for 1904.

[Irrigated area, 8,000 acres.]

Month.	Discharge in second-feet.			Total in acre-feet.	Depth of run-off, in inches, over irrigated area.
	Maximum.	Minimum.	Mean.		
April 16-30[b]			100	2,975	4.46
May			130	7,993	12.0
June	190	111	145	8,628	12.9
July	214	112	164	10,080	15.1
August	170	130	149	9,162	13.7
September			100	5,950	8.92
October 1-15[c]			90	2,678	4.01
The period	214	111	130	47,470	71.1

[a] Approximate. [b] Estimated April 15 to June 6. [c] Estimated September 1 to October 15.

GOVERNMENT CANAL NO. 3 NEAR TOPPENISH, WASH.

This canal heads in Yakima River in sec. 28, T. 11 N., R. 20 E., near Toppenish. Like the Old Reservation canal, it was built from a fund derived from the sale of the Wenache fisheries. It irrigates about 2,300 acres in the Yakima Indian Reservation. No water was ever appropriated for it. Its average flow is about 10 second-feet.

SUNNYSIDE CANAL NEAR YAKIMA, WASH.

This canal, which is owned and operated by the Washington Irrigation Company, takes water from the east bank of Yakima River, in sec. 28, T. 12 N., R. 19 E., nearly opposite the intake of the Old Reservation canal No. 1. It is several times larger than any other canal in the Yakima region, the maximum flow being about 630 second-feet. Six discharge measurements were taken at the headworks during the summer. Miscellaneous measurements and gage readings were taken at eight other places along the canal, for the purpose of obtaining seepage and wastage from the canal. The latter never exceeded 2 per cent, and very little of this amount found its way directly to the river. On June 10 a seepage experiment was made upon a stretch of the canal extending from the headworks to Zillah, a distance of 17 miles. The result showed a seepage loss of 4.5 per cent in this distance. Previous to this experiment all the laterals leading from the canal were closed and the canal allowed to regulate itself for twelve hours. The measurements at the beginning and end of the stretch were both taken by the same meter, and all chances of error eliminated. The section experimented upon is the oldest section of the canal, excavated in very fine volcanic soil. There has also

been deposited from time to time a fine silt of a clayish nature, which serves to make the banks more or less impervious to water. The first experiment was checked upon August 15, by a similar test over the same section, with the finding of a loss of 4 per cent due to seepage.

It is interesting to compare this with a seepage test made upon the first 9 miles of the Kennewick canal later, where the loss due to seepage was found to be 26 per cent. (See p. 138.)

The value of the water right on the basis of a duty of 160 acres per second-foot is $30 per acre. The value of the land, with the water right attached, is $60 to $90 per acre.

Discharge measurements of Sunnyside canal near Yakima, Wash., in 1904.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
April 22	G. H. Bliss	153	3.05	2.54	467
May 26	do	184	3.00	3.18	553
June 10	do	160	3.04	2.79	[a] 487
July 2	G. F. Harley	202	3.12	3.62	630
August 15	G. H. Bliss	192	2.93	3.33	[b] 564
August 16	do	206	3.09	3.50	[c] 636

[a] 4.5 per cent seepage in 17 miles.
[b] 4 per cent seepage in 17 miles.
[c] Integration method at bridge.

Mean daily gage height, in feet, of Sunnyside canal near Yakima, Wash., for 1904.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1		2.96	3.25	3.54	3.46	3.37	2.58
2		2.96	3.25	3.62	3.46	3.37	2.58
3		2.96	3.25	(a)	3.46	3.37	2.58
4		2.96	3.25	(a)	3.46	3.37	2.54
5		2.96	3.25	(a)	3.50	3.37	2.52
6		3.04	3.25	(a)	3.54	3.35	2.50
7		3.04	3.25	(a)	3.54	3.33	2.50
8		3.04	3.21	2.17	3.54	3.29	2.50
9		3.04	2.79	2.65	3.54	3.29	2.50
10		2.00	2.79	3.29	3.54	3.29	2.46
11		3.04	3.12	3.33	3.54	3.29	2.33
12		3.04	3.12	3.37	3.54	3.25	2.33
13		3.04	3.06	3.41	3.55	3.12	2.33
14		3.04	3.06	3.46	3.56	3.08	2.29
15		3.04	3.14	3.46	3.33	3.04	2.29
16		3.10	3.17	3.46	3.58	2.79	
17		3.08	3.19	3.46	3.56	2.79	
18		3.10	3.29	3.46	3.56	2.79	
19		3.12	3.29	3.46	3.56	2.79	
20		3.12	3.29	3.46	3.56	2.79	
21		3.12	3.33	3.46	3.56	2.79	

[a] Water shut off.

Mean daily gage height, in feet, of Sunnyside canal near Yakima, Wash., for 1904—Continued.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
22	2.54	3.12	3.35	3.46	3.56	2.79	.....
23	2.79	3.12	3.35	3.46	3.56	2.79	.....
24	2.83	3.12	3.42	3.46	3.56	2.75	.....
25	2.83	3.14	3.39	3.46	3.56	2.71	.....
26	2.83	3.18	3.54	3.46	3.56	2.71	.....
27	2.83	3.19	3.46	3.46	3.56	2.71	.....
28	2.90	3.25	3.46	3.46	3.56	2.62	.....
29	2.92	3.25	3.50	3.46	3.53	2.62	.....
30	2.95	3.25	3.54	3.46	3.50	2.62	.....
31	.....	3.25	.....	3.46	3.44	.....	.....

Mean daily discharge, in second-feet, of Sunnyside canal near Yakima, Wash., for 1904.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	513	558	613	597	580	468
2	.....	513	558	629	597	580	468
3	.....	513	558	0	597	580	468
4	.....	513	558	0	597	580	464
5	.....	513	558	0	605	580	462
6	.....	525	558	0	613	576	460
7	.....	525	558	0	613	572	460
8	.....	525	552	433	613	565	460
9	.....	525	491	475	613	565	460
10	.....	419	491	565	613	565	456
11	.....	525	537	572	613	565	445
12	.....	525	537	580	613	558	445
13	.....	525	528	587	615	537	445
14	.....	525	528	597	617	531	442
15	.....	525	540	597	572	525	442
16	.....	534	545	597	621	491	.....
17	.....	531	548	597	617	491	.....
18	.....	534	565	597	617	491	.....
19	.....	537	565	597	617	491	.....
20	.....	537	565	597	617	491	.....
21	.....	537	572	597	617	491	.....
22	464	537	576	597	617	491	.....
23	491	537	576	597	617	491	.....
24	496	537	589	597	617	486	.....
25	496	540	583	597	617	481	.....
26	496	547	613	597	617	481	.....
27	496	548	597	597	617	481	.....
28	505	558	597	597	617	472	.....
29	508	558	605	597	617	472	.....
30	512	558	613	597	605	472	.....
31	.....	558	.....	597	593	.....	.....

Rating table for Sunnyside canal near Yakima, Wash., from April 22 to October 15, 1904.

Gage height.	Discharge.	Gage height.	Discharge	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.00	419	2.45	455	2.90	505	3.35	576
2.05	423	2.50	460	2.95	512	3.40	585
2.10	427	2.55	465	3.00	519	3.45	595
2.15	431	2.60	470	3.05	526	3.50	605
2.20	435	2.65	475	3.10	534	3.55	615
2.25	439	2.70	480	3.15	542	3.60	625
2.30	443	2.75	486	3.20	550	3.65	636
2.35	447	2.80	492	3.25	558	3.70	647
2.40	451	2.85	498	3.30	567	3.75	658

The above table is based upon 6 discharge measurements made during 1904. It is fairly well defined between gage heights 2.50 feet and 3.60 feet.

Estimated monthly discharge of Sunnyside canal near Yakima, Wash., for 1904.

[Irrigated area, 35,000 acres.]

Month.	Discharge in second-feet.			Total in acre-feet.	Depth of run-off in inches, over irrigated area.
	Maximum.	Minimum.	Mean.		
April 16–30 [a]	512	464	496	14,760	5.06
May	558	419	529	32,530	11.2
June	613	491	561	33,380	11.5
July [b]	629	433	585	30,170	10.3
August	617	572	610	37,510	12.9
September	580	472	524	31,180	10.7
October 1–15	468	442	456	13,570	4.65
The period	629	419	547	193,100	66.3

[a] Estimated April 16–21. [b] Water shut off 5 days.

GILBERT CANAL NEAR TOPPENISH, WASH.

This canal heads in a slough from Yakima River in sec. 19, T. 11 N., R. 20 E., in the Yakima Indian Reservation. It was built by an association of men who lease lands from the Indians. At the expiration of the lease the canal belongs to the land through which it runs. A large part, probably 50 per cent, of the water taken into the canal is wasted into sloughs which drain into the river. No appropriation of water has been made and no water right acquired.

Discharge measurements of Gilbert canal near Toppenish, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
June 9 [a]	G. F. Harley	14	23	2.30	1.60	53
September 6 [b]	do	7	7.6	1.62	1.04	12.3
September 6 [c]	do	6	2.9	.86	.40	2.5

[a] Main branch. [b] East branch. [c] West branch.

Mean daily gage height, in feet, of Gilbert canal (east branch) near Toppenish, Wash., for 1904.

Day.	June. [a]	July.	Aug.	Sept.	Day.	June. [a]	July.	Aug.	Sept.
1	1.79	1.75	1.42	1.25	17	1.83	1.33	1.67	.....
2	1.75	1.75	1.42	1.17	18	1.83	1.29	1.42	.....
3	1.75	1.75	1.37	1.08	19	1.79	1.29	1.58	.....
4	1.75	1.42	1.37	1.06	20	1.79	1.33	1.58	.....
5	1.75	1.42	1.33	1.05	21	1.83	1.50	1.42	.....
6	1.79	1.54	1.33	1.04	22	1.87	1.50	1.17	.....
7	1.79	1.67	1.33	.....	23	1.92	1.67	1.08	.....
8	1.67	1.42	1.50	.....	24	1.67	1.50	1.00	.....
9	1.62	1.25	1.50	.....	25	1.67	1.50	1.17	.....
10	1.58	1.25	1.75	.....	26	1.67	1.67	1.00	.....
11	1.58	1.25	1.71	.....	27	1.67	1.75	.96	.....
12	1.58	1.33	1.42	.....	28	1.67	1.75	.92	.....
13	1.58	1.33	1.33	.....	29	1.75	1.67	.92	.....
14	1.62	1.37	1.42	.....	30	1.75	1.67	1.25	.....
15	1.67	1.37	1.42	.....	31	.....	1.58	([b])	.....
16	1.79	1.33	1.50	.....					

[a] June 1 to 23, gage above the forks. [b] Water shut off.

Mean daily discharge, in second-feet, of Gilbert canal (east branch) near Toppenish, Wash., for 1904.

Day.	June.	July.	Aug.	Sept.	Day.	June.	July.	Aug.	Sept.
1	58	35	20	15	17	60	17	30	.....
2	57	35	20	14	18	60	16	20	.....
3	57	35	18	13	19	58	16	25	.....
4	57	20	18	13	20	58	17	25	.....
5	57	20	17	12	21	60	22	20	.....
6	58	23	17	12	22	62	22	14	.....
7	58	30	17	.....	23	65	30	13	.....
8	55	20	22	.....	24	30	22	12	.....
9	53	15	22	.....	25	30	22	14	.....
10	51	15	35	.....	26	30	30	12	.....
11	51	15	32	.....	27	30	35	11	.....
12	51	17	20	.....	28	30	35	11	.....
13	51	17	17	.....	29	35	30	11	.....
14	53	18	20	.....	30	35	30	15	.....
15	55	18	20	.....	31	.....	25	0	.....
16	58	17	22	.....					

Mean daily gage height, in feet, of Gilbert canal (west branch) near Toppenish, Wash., for 1904.

Day.	June.[a]	July.	Aug.	Sept.	Day.	June.[a]	July.	Aug.	Sept.
1	.....	1.33	1.00	0.58	17	.....	1.17	1.00	.....
2	.....	1.33	1.00	.50	18	.....	1.08	.92	.....
3	.....	1.33	1.00	.54	19	.....	1.17	1.00	.....
4	.....	1.17	1.00	.50	20	.....	1.17	1.00	.....
5	.....	1.17	1.00	.45	21	.....	1.00	.92	.....
6	.....	1.50	1.00	.40	22	.....	1.00	.67	.....
7	.....	1.42	1.00	.....	23	.....	1.08	.58	.....
8	.....	1.25	1.00	.....	24	1.33	1.00	.54	.....
9	.....	1.17	1.00	.....	25	1.33	1.00	.58	.....
10	.....	1.17	1.00	.....	26	1.33	1.00	.50	.....
11	.....	1.17	1.00	.....	27	1.33	1.08	.50	.....
12	.....	1.25	.92	.....	28	1.33	1.17	.50	.....
13	.....	1.25	.83	.....	29	1.37	1.17	.50	.....
14	.....	1.25	.92	.....	30	1.33	1.08	.58	.....
15	.....	1.25	.92	.....	31	.....	1.00	(b)	.....
16	.....	1.17	1.00	.....					

[a] June 1 to 23, gage above the forks.

[b] Water shut off.

Mean daily discharge, in second-feet, of Gilbert canal (west branch) near Toppenish, Wash., for 1904.

Day.	June.	July.	Aug.	Sept.	Day.	June.	July.	Aug.	Sept.
1	.....	35	12	4	17	.....	25	12	.....
2	.....	35	12	3	18	.....	19	9	.....
3	.....	35	12	3.5	19	.....	25	12	.....
4	.....	25	12	3.0	20	.....	25	12	.....
5	.....	25	12	2.6	21	.....	12	9	.....
6	.....	47	12	2.5	22	.....	12	5	.....
7	.....	41	12	.....	23	.....	19	4	.....
8	.....	30	12	.....	24	35	12	4	.....
9	.....	25	12	.....	25	35	12	4	.....
10	.....	25	12	.....	26	35	12	3	.....
11	.....	25	12	.....	27	35	19	3	.....
12	.....	30	9	.....	28	35	25	3	.....
13	.....	30	7	.....	29	36	25	3	.....
14	.....	30	9	.....	30	35	19	4	.....
15	.....	30	9	.....	31	.....	12	0	.....
16	.....	25	12	.....					

Estimated monthly discharge [a] of Gilbert canal near Toppenish, Wash., for 1904.

[Irrigated area, 3,000 acres.]

Month.	Discharge in second-feet.			Total in acre-feet.	Depth of run-off in inches, over irrigated area.
	Maximum.	Minimum.	Mean.		
April 16–30 [b]			25.0	744	2.98
May			40.0	2,460	9.84
June	71	51	58.9	3,505	14.0
July	71	34	47.9	2,945	11.8
August [c]	47	14	28.6	1,702	6.81
September [d]	19	15	17.0	1,012	4.05
October 1–15			10.0	298	1.19
The period	71	14	35.1	12,670	50.7

[a] Approximate.
[b] Estimated April 16 to May 31.
[c] Water shut off one day.
[d] Estimated September 7 to October 15.

HATCH CANAL NEAR TOPPENISH, WASH.

This canal is also called the Alfalfa Siding canal. It heads in a slough from Yakima River on its right bank near Toppenish in sec. 30, T. 10 N., R. 21 E. The status of this canal as regards ownership and water rights is the same as that of the Gilbert canal above. No gaging station was maintained on it. Two discharge measurements were taken with the following results:

Discharge measurements of Hatch canal near Toppenish, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Second-feet.*
June 9	G. F. Harley	6	6.1	2.10	12.8
September 6	do	6	4.0	1.00	4.0

PROSSER FALLS IRRIGATION COMPANY'S POWER CANAL AT PROSSER, WASH.

This company pumps water from Yakima River at Prosser, to be used for domestic purposes and irrigation. The water is carried to the wheels of the pumps by a flume 12 feet wide and a mean depth of water of about 6 feet, carrying on an average 205 second-feet of water when both pumps are running. Most of this amount of water is only used for the power purposes, however, and is spilled directly back into the river and is immediately available for irrigation lower down the valley.

The pumping plant consists of two Smith-Vaile pumps, of two cylinders each, of inside diameter of 25 inches and length of stroke of 24 inches. Diameter of wheel, 52 inches.

The average amount of water pumped is about 15 second-feet, or only about 7 per cent of the amount passing through the flume.

Discharge measurements of Prosser Falls Irrigation Company's power canal at Prosser, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 30	G. F. Harley	12	108	1.93	22.44	210
July 26	do	12	71	2.94	19.05	209
August 11	do	12	55	4.03	17.65	222
September 10	do	12	49	3.96	17.20	194
September 17	G. H. Bliss	12	61	2.85	18.25	175

[a] Change in velocities due to change in stage of river.

Mean daily discharge, in second-feet, of Prosser Falls Irrigation Company's power canal at Prosser, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	210	216	205	194	209
2	.....	0	216	209	194	209
3	.....	0	216	200	194	209
4	.....	210	216	200	194	209
5	.....	210	216	200	194	209
6	.....	210	216	200	194	209
7	.....	210	216	200	194	209
8	.....	210	216	212	194	209
9	.....	210	216	212	194	209
10	.....	210	216	212	194	209
11	.....	210	212	212	194	.....
12	.....	210	212	212	194	.....
13	.....	210	212	212	194	.....
14	.....	210	212	212	194	.....
15	.....	210	212	210	194	.....
16	.....	210	212	210	194	.....
17	.....	210	210	200	194	.....
18	.....	216	210	200	194	.....
19	.....	216	210	200	194	.....
20	.....	216	210	194	194	.....
21	.....	216	210	194	194	.....
22	.....	216	210	194	194	.....
23	.....	216	209	194	194	.....
24	.....	216	209	194	194	.....
25	.....	220	209	194	194	.....
26	.....	220	209	194	194	.....
27	.....	220	209	194	194	.....
28	.....	220	209	194	200	.....
29	.....	220	204	194	200	.....
30	210	220	204	194	200	.....
31	210	.....	204	194	.....	.....

Estimated monthly discharge of Prosser Falls Irrigation Company's power canal at Prosser, Wash., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April 16–30	.....	.....	190	5,653
May	.....	.....	210	12,910
June	220	210	214	12,730
July	216	204	212	13,040
August	212	194	201	12,360
September	200	194	195	11,600
October 1–15	209	209	209	6,218
The period	220	194	205	74,510

Mean daily discharge,[a] in second-feet, of Prosser Falls Irrigation Company's irrigating canal at Prosser, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	14.7	15.8	14.5	14.9	14.9
2	.....	(b)	15.8	14.5	14.9	14.9
3	.....	(b)	15.8	13.5	14.9	14.9
4	.....	14.9	15.8	13.5	14.9	14.9
5	.....	14.9	15.8	13.5	14.9	14.9
6	.....	14.9	15.8	13.5	14.9	14.9
7	.....	14.9	15.8	13.5	14.9	14.9
8	.....	14.9	15.8	14.5	14.9	14.9
9	.....	14.9	15.8	14.5	14.9	13.5
10	.....	14.9	15.8	14.5	14.9	13.5
11	.....	14.5	15.8	14.5	14.9	.....
12	.....	14.5	15.8	14.5	14.9	.....
13	.....	14.5	15.8	14.5	14.9	.....
14	.....	14.5	15.8	14.5	14.9	.....
15	.....	14.7	15.4	14.5	14.9	.....
16	.....	14.7	15.4	14.5	14.9	.....
17	.....	14.7	15.4	14.5	14.9	.....
18	.....	15.5	15.4	14.5	14.9	.....
19	.....	15.5	15.4	14.5	14.9	.....
20	.....	15.8	15.4	14.5	14.9	.....
21	.....	15.8	15.4	14.5	14.9	.....
22	.....	15.8	15.4	14.5	14.9	.....
23	.....	15.8	15.4	14.5	14.9	.....
24	.....	15.8	15.4	14.9	14.9	.....
25	.....	16.3	15.4	14.9	14.9	.....
26	.....	16.3	15.4	14.9	14.9	.....
27	.....	16.3	15.4	14.9	14.9	.....
28	.....	16.3	15.4	14.9	14.9	.....
29	.....	16.3	15.4	14.9	14.9	.....
30	14.5	16.3	15.4	14.9	14.9	.....
31	14.5	.....	15.4	14.9	.....	.....

[a] Computed from revolutions of the pumps.

[b] Pumps not running.

Estimated monthly discharge[a] of Prosser Falls Irrigation Company's irrigating canal at Prosser, Wash., for 1904.

[Irrigated area, 1,200 acres.]

Month.	Discharge in second-feet.			Total in acre-feet.	Depth of run-off in inches, over irrigated area.
	Maximum.	Minimum.	Mean.		
April 16–30	.....	.....	14.5	431	4.31
May	.....	.....	14.5	892	8.92
June[b]	16.3	14.7	15.1	898	8.98
July	15.8	15.4	15.6	959	9.59
August	14.9	13.5	14.4	885	8.85
September	14.9	14.9	14.9	887	8.87
October 1–15	.....	.....	14.6	434	4.34
The period	16.3	13.5	14.8	5,386	53.9

[a] Included in discharge of Power canal. [b] Water shut off two days.

LEDBETTER CANAL NEAR PROSSER, WASH.

This canal heads into Yakima River, above the falls at Prosser, just opposite the intake of the Prosser Falls Irrigation Company's flume. The canal has never been completed, and that part of it which had already been constructed has been allowed to fall into a dilapidated condition.

The proposed canal contemplated the irrigation of about 125,000 acres of land lying north and east of the Rattlesnake Range in the Columbia Valley and 25,000 acres additional lying upon the right bank of Yakima River above that covered by the Kennewick canal.

During the season of 1904 there were 3 or 4 miles in use by farmers who maintained it for the benefits derived, and a total acreage covered of about 360 acres.

No measurements were taken upon the canal.

KIONA CANAL NEAR KIONA, WASH.

This canal heads in the left bank of Yakima River about 4 miles west of Kiona in sec. 10, T. 9 N., R. 26 E. The canal is controlled by the Northern Pacific Irrigation Company. On account of the shifting of the channel at the gaging station the estimates of discharge of this canal are only approximate. Less than 5 per cent of the water taken in at the head-gates was wasted directly into the river.

Discharge measurements of Kiona canal near Kiona, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec. feet.*
April 14	G. H. Bliss	8	7.4	1.37	1.10	10.2
June 3	G. F. Harley	8	14.2	1.41	2.55	20.1
September 8	do	8	13.5	1.11	2.60	15.0

Mean daily gage height, in feet, of Kiona canal near Kiona, Wash., for 1904.

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	June.	July.	Aug.	Sept.	Oct.
1	.....	2.52	2.58	2.67	2.67	17	2.50	2.42	2.54	2.71	.....
2	.....	2.58	2.67	2.67	2.75	18	2.50	2.33	2.50	2.71	.....
3	.....	2.67	2.58	2.67	2.83	19	2.54	2.50	2.46	2.71	.....
4	.....	(a)	2.50	2.67	2.71	20	2.56	2.50	2.46	2.71	.....
5	.....	2.67	2.44	2.67	2.71	21	2.62	2.50	2.46	2.71	.....
6	.....	2.64	2.42	2.67	2.71	22	2.60	2.46	2.50	2.75	.....
7	2.62	2.64	2.42	2.67	2.71	23	2.58	2.42	2.54	2.79	.....
8	2.62	2.64	2.44	2.67	2.71	24	2.58	2.33	2.62	2.67	.....
9	2.54	2.62	2.46	2.67	2.71	25	2.58	2.50	2.67	2.67	.....
10	2.50	2.62	2.39	2.67	2.71	26	2.50	2.58	2.67	2.67	.....
11	2.48	2.62	2.39	2.67	2.71	27	2.42	2.62	2.67	2.67	.....
12	2.37	2.60	2.33	2.71	2.71	28	2.50	2.62	2.67	2.67	.....
13	2.33	2.58	2.33	2.71	2.71	29	2.50	2.54	2.67	2.67	.....
14	2.50	2.58	2.33	2.71	2.71	30	2.50	2.56	2.67	2.67	.....
15	2.50	2.54	2.54	2.71	2.71	31	.....	2.56	2.67	.....	.....
16	2.50	2.54	2.54	2.71	2.71						

[a] Water shut off.

Mean daily discharge, in second-feet, of Kiona canal near Kiona, Wash., for 1904.

Day.	June.	July.	Aug.	Sept.	Oct.	Day.	June.	July.	Aug.	Sept.	Oct.
1	.....	20	21	19	19	17	20	18	20	21	.....
2	.....	21	24	19	23	18	20	17	20	21	.....
3	.....	24	21	19	25	19	20	20	19	21	.....
4	.....	0	20	19	21	20	21	20	19	21	.....
5	.....	24	18	19	21	21	23	20	19	21	.....
6	.....	24	18	19	21	22	22	19	20	23	.....
7	23	24	18	19	21	23	21	18	20	24	.....
8	23	24	18	19	21	24	21	17	16	19	.....
9	20	23	19	19	21	25	21	20	19	19	.....
10	20	23	17	19	21	26	20	21	19	19	.....
11	19	23	17	19	21	27	18	23	19	19	.....
12	18	22	17	21	21	28	20	23	19	19	.....
13	17	21	17	21	21	29	20	20	19	19	.....
14	20	21	17	21	21	30	20	21	19	19	.....
15	20	20	20	21	21	31	.....	21	19	.....	.....
16	20	20	20	21	21						

Estimated monthly discharge of Kiona canal near Kiona, Wash., for 1904.

[Irrigated area, 800 acres.]

Month.	Discharge in second-feet.			Total in acre-feet.	Depth of run-off in inches, over irrigated area.
	Maximum.	Minimum.	Mean.		
April 16–30 [a]			17.0	506	7.59
May			20.0	1,230	18.4
June	23	17	20.0	1,190	17.8
July [b]	24	17	21.1	1,256	18.8
August	24	17	19.0	1,168	17.5
September	24	19	20.3	1,208	18.1
October 1–15	25	19	21.3	634	9.51
The period	25	17	19.9	7,192	107.7

[a] Estimated April 15 to June 6th. [b] Water shut off one day.

KIONA WATER SUPPLY COMPANY'S CANAL NEAR KIONA, WASH.

This canal heads in the left bank of Yakima River, just above Kiona. It is owned by a stock company of 150 shares. It is a power canal used to turn small irrigating wheels. Nearly all the water taken in at the head is returned to the river. The discharge as measured June 6 was 18.5 second-feet.

KENNEWICK CANAL NEAR KENNEWICK, WASH.

This canal is owned and operated by the Northern Pacific Irrigation Company. Next to the Sunnyside it is the largest irrigation canal in the Yakima Valley. It takes water from the Yakima River on its right bank just above Horn Rapids, about 11 miles north of Kiona, in sec. 3, T. 10 N., R. 27 E. Besides two measurements taken at the head-gates, various other points along the canal were measured in order to determine the amount of water wasted and the loss due to seepage. The water wasted directly into the river was found to be about 15 per cent of the discharge at the intake, of which about 10 per cent was spilled into Columbia River.

Careful measurements taken September 9 at two points 8 miles apart near the upper end of the canal showed a seepage of 26 per cent in this distance. All the laterals along this stretch had been tightly closed and the canal allowed to regulate itself before the measurements were made. Over the stretch tested the canal is excavated in sand and gravel for almost the entire distance, differing in this respect from the Sunnyside canal. The Kennewick canal is also of more recent construction.

Discharge measurements of Kennewick canal near Kennewick, Wash., in 1904.

Date	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
June 4	G. F. Harley	58	1.65	2.71	96
September 9	do	75	1.64	3.20	123
September 9[a]	do	28	3.25	[b]2.10	91

[a] Seepage test, flume No. 1. [b] Gage in flume.

Mean daily gage height, in feet, of Kennewick canal near Kennewick, Wash., for 1904.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	2.38	2.75	3.1	3.2	3.3	3.2
2	.....	2.38	2.75	3.1	3.2	3.2	3.2
3	.....	2.38	2.75	3.1	3.1	3.2	3.2
4	.....	2.38	2.75	3.1	3.3	3.2	3.2
5	.....	2.38	2.75	3.1	3.3	3.2	3.2
6	.....	2.38	2.75	3.1	3.3	3.2	3.2
7	.....	2.38	2.79	3.1	3.25	3.2	3.1
8	1.00	2.38	2.79	3.1	3.35	3.2	3.1
9	1.33	2.38	2.87	3.1	3.2	3.2	3.1
10	1.50	2.46	2.92	3.1	3.4	3.2	3.1
11	2.17	2.46	2.25	3.1	3.4	3.2	3.1
12	2.17	2.46	2.25	3.1	2.9	3.2	3.1
13	2.17	2.50	2.25	3.1	3.3	3.2	3.1
14	2.17	2.50	2.50	3.1	3.4	3.2	3.1
15	2.17	2.58	2.42	3.1	3.4	3.2	3.1
16	2.17	2.67	3.0	3.1	3.4	3.2	3.1
17	2.17	2.67	3.0	3.1	3.4	3.2	3.1
18	2.17	2.67	3.0	3.1	3.4	3.2	3.1
19	2.17	2.67	3.0	3.0	3.0	3.2	(a)
20	2.17	2.67	3.1	2.9	3.15	3.2	(a)
21	2.21	2.67	2.8	2.9	3.15	3.2	3.0
22	2.21	2.67	2.8	2.85	3.4	3.2	3.0
23	2.21	2.67	3.0	3.00	3.4	3.2	3.1
24	2.21	2.67	3.1	2.95	3.4	3.25	3.0
25	2.17	2.75	3.1	2.80	3.3	3.25	2.9
26	.83	2.75	3.1	2.75	3.3	3.25	2.9
27	1.00	2.75	3.1	2.75	3.25	3.25	3.0
28	2.50	2.75	3.1	2.60	3.2	3.25	3.0
29	2.50	2.75	3.1	2.70	3.3	3.2	2.9
30	2.50	2.75	3.1	2.90	3.3	3.2	2.9
31	.....	2.75	.....	3.00	3.2	.....	2.9

[a] Water shut off.

Mean daily discharge, in second-feet, of Kennewick canal near Kennewick, Wash., for 1904.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	73	98	123	125	127	125
2	.....	73	98	123	125	125	125
3	.....	73	98	123	123	125	125
4	.....	73	98	123	127	125	125
5	.....	73	98	123	127	125	125
6	.....	73	98	123	127	125	125
7	.....	73	102	123	126	125	123
8	10	73	102	123	128	125	123
9	18	73	106	123	125	125	123
10	20	77	110	123	129	126	123
11	59	77	63	123	129	125	123
12	59	77	63	123	110	125	123
13	59	80	63	123	127	125	123
14	59	80	80	123	129	125	123
15	59	87	75	123	129	125	123
16	59	92	116	123	129	125	123
17	59	92	116	123	129	125	123
18	59	92	116	123	129	125	123
19	59	92	116	116	116	125	0
20	59	92	123	110	124	125	0
21	48	92	102	110	124	125	116
22	48	92	102	105	129	125	116
23	48	92	116	116	129	125	123
24	48	92	123	112	129	126	116
25	59	98	123	102	127	126	110
26	8	98	123	98	127	126	110
27	10	98	123	98	126	126	116
28	80	98	123	116	125	126	116
29	80	98	123	94	127	125	110
30	80	98	123	110	127	125	110
31	.....	98	.....	116	125	.....	110

Estimated monthly discharge of Kennewick canal near Kennewick, Wash., for 1904.

[Irrigated area, 6,000 acres.]

Month.	Discharge in second-feet.			Total in acre-feet.	Depth of run-off in inches, over irrigated area.
	Maximum.	Minimum.	Mean.		
April 16–30	59	8	53.6	1,595	3.19
May	98	73	85.5	5,257	10.5
June	123	63	101	6,010	12.0
July	123	94	117	7,194	14.4
August	129	110	126	7,747	15.5
September	127	125	126	7,498	15.0
October 1–15	125	123	124	3,690	7.38
The period	129	8	107	38,990	78.0

GROSSCUP'S CANAL NEAR KIONA, WASH.

This canal is sometimes called the Lower Yakima canal. It heads into Yakima River upon its left bank, at Horn Rapids directly opposite the intake of the Kennewick canal. The same diversion weir is used for both canals, as is also the same water appropriation.

During the season of 1904, 5½ miles were constructed, but no water used for irrigation purposes. The canal as constructed is owned and operated by Mr. Grosscup. The Northern Pacific Irrigation Company, of whom the right of way was secured, reserve the right to extend the canal at any time and to supply the present owner with what water he needs.

SINCLAIR AND COBB CANAL NEAR NORTH YAKIMA, WASH.

There are no canals of any consequence taking water from Tieton River. A small irrigating canal heads in Tieton River on its left bank, about 3 miles above its mouth. It is owned and operated by Sinclair and Cobb, and carries about 5 second-feet of water. The total discharge of Tieton River therefore flows practically unused into Naches River.

SELAH VALLEY CANAL NEAR NORTH YAKIMA, WASH.

The only important canal taking water from Naches River above the mouth of the Tieton is the Selah Valley canal. There are a few canals above the Selah Valley, but they are small private ditches, and their combined flow would probably not exceed 15 second-feet.

The Selah Valley canal heads in Naches River on its left bank about 1 mile above the mouth of the Tieton in sec. 35, T. 15 N., R. 16 E. With the exception of the Power canal it is the largest canal taking water from the Naches. The canal ends in the sandy prairie some distance from the river. The wasteways are for emergencies only. Very little water is wasted directly into the river.

Discharge measurements of Selah Valley canal near North Yakima, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
April 27	G. F. Harley	14	14.0	1.60	2.05	22.4
June 8	do	13	12.6	1.44	1.94	18.2
July 9	do	15	18.9	1.66	2.36	31.6
July 9	do	16	24.7	1.91	2.76	47.6
July 9	do	17	31.3	2.14	3.17	66.9
July 15	do	17	36.7	2.30	3.48	84.4
August 12	do	7	17.5	3.17	.....	[a] 54.4

[a] "Twin Flume" 5 miles below the head-gates.

Mean daily gage height, in feet, of Selah Valley canal near North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	3.50	3.50	3.42	3.54	3.00
2	.....	3.50	3.50	3.50	3.54	3.00
3	.....	3.50	3.50	3.50	3.54	3.00
4	.....	3.50	3.50	3.50	3.54	3.00
5	.....	3.50	2.00	3.50	3.54	3.00
6	.....	3.50	2.00	3.50	3.54	3.00
7	.....	3.50	2.00	3.50	3.54	3.00
8	.....	3.50	2.00	3.50	3.54	3.00
9	.....	3.50	2.50	3.58	3.54	3.00
10	.....	3.50	2.67	3.58	3.54	3.00
11	.....	3.50	2.67	3.58	3.54	3.00
12	.....	3.50	2.83	3.50	3.54	3.00
13	.....	3.50	3.17	3.42	3.54	3.00
14	.....	3.42	3.50	3.58	3.54	3.00
15	.....	3.50	3.50	3.58	3.54	3.00
16	.....	3.50	3.33	3.58	3.54	.....
17	.....	3.50	3.25	3.58	3.50	.....
18	.....	3.50	3.42	3.58	3.50	.....
19	0.50	3.50	3.42	3.58	3.50	.....
20	0.50	3.50	3.50	3.58	3.33	.....
21	2.33	3.50	3.50	3.58	3.33	.....
22	2.92	3.50	3.50	3.58	3.33	.....
23	3.17	3.42	3.50	3.58	3.33	.....
24	3.33	3.42	3.50	3.58	3.33	.....
25	3.17	3.42	3.50	3.58	3.33	.....
26	3.17	3.50	3.50	3.54	3.25	.....
27	3.33	3.50	3.50	3.54	3.17	.....
28	3.42	3.50	3.50	3.54	3.00	.....
29	3.42	3.50	3.50	3.54	3.00	.....
30	3.42	3.50	3.50	3.54	3.00	.....
31	3.50	.....	3.50	3.54	.....	.....

Mean daily discharge, in second-feet, of Selah Valley canal near North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	84	84	79	87	60
2	.....	84	84	84	87	60
3	.....	84	84	84	87	60
4	.....	84	84	84	87	60
5	.....	84	20	84	87	60
6	.....	84	20	84	87	60
7	.....	84	20	84	87	60
8	.....	84	20	84	87	60
9	.....	84	37	89	87	60
10	.....	84	43	89	87	60
11	.....	84	43	89	87	60
12	.....	84	52	84	87	60
13	.....	84	79	79	87	60
14	.....	79	84	89	87	60
15	.....	84	84	89	87	60
16	.....	84	77	89	87	60

Mean daily discharge, in second-feet, of Selah Valley canal near North Yakima, Wash., for 1904—Continued.

Day.	May.	June.	July	Aug.	Sept.	Oct.
17	.....	84	72	89	84	48
18	.....	84	79	89	84	43
19	2	84	79	89	84	43
20	2	84	84	89	77	.....
21	31	84	84	89	77	.....
22	55	84	84	89	77	.....
23	67	79	84	89	77	.....
24	77	79	84	89	77	.....
25	67	79	84	89	77	.....
26	67	84	84	87	72	.....
27	77	84	84	87	67	.....
28	79	84	84	87	60	.....
29	79	84	84	87	60	.....
30	79	84	84	87	60	.....
31	84	.....	84	87	.....	.....

Rating table for Selah Valley canal near North Yakima, Wash., from May 19 to October 15, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.80	15.1	2.30	29.7	2.75	47.6	3.20	69.4
1.85	16.3	2.35	31.4	2.80	49.9	3.25	71.8
1.90	17.6	2.40	33.1	2.85	52.3	3.30	74.3
1.95	19.0	2.45	34.9	2.90	54.7	3.35	76.7
2.00	20.4	2.50	36.8	2.95	57.1	3.40	79.2
2.05	21.9	2.55	38.8	3.00	59.6	3.45	81.6
2.10	23.4	2.60	40.9	3.05	62.0	3.50	84.1
2.15	24.9	2.65	43.1	3.10	64.5	3.55	86.5
2.20	26.5	2.70	45.3	3.15	66.9	3.60	89.0
2.25	28.1						

This table is based upon 6 discharge measurements made during 1904. It is well defined between gage heights 2.00 feet and 3.50feet. The table has been extended beyound these limits.

Estimated monthly discharge of Selah Valley canal near North Yakima, Wash., for 1904.

[Irrigated area, 6,000 acres.]

Month.	Discharge in second-feet.			Total in acre-feet.	Depth of run-off in inches, over irrigated area.
	Maximum.	Minimum.	Mean.		
April 16–30 [a]			45.0	1,339	2.68
May			59.0	3,511	7.04
June	84	79	83.3	4,957	9.91
July	84	20	69.5	4,273	8.55
August	89	79	86.7	5,331	10.7
September	87	60	80.8	4,808	9.62
October 1–15	60	60	60.0	1,785	3.57
The period	89	60	72.0	26,000	52.1

[a] Estimated April 16 to May 18.

WAPATOX CANAL NEAR NORTH YAKIMA, WASH.

This canal heads in the left bank of Naches River opposite the mouth of the Tieton in sec. 36, T. 15 N., R. 16 E. It is maintained by a stock company of 100 equal shares. Owing to the fact that the velocity of the current in the canal was greatly influenced by changes in the stage of the river and in the opening of the headgate, the canal was not accurately rated. The estimates of discharge are therefore only approximate.

Discharge measurements of Wapatox canal near North Yakima, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 19	G. F. Harley	9	3.46	0.62	0.42	2.2
July 8	do	9	12.3	.80	1.26	9.9
July 9	do	10	25.3	1.38	2.48	35.
July 16	do	10	19.34	1.45	1.90	27.9
July 28	do	10	22.0	1.50	2.19	33.

Mean daily gage height, in feet, of Wapatox canal near North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	2.67	2.88	2.25	2.58	1.83
2	.....	2.67	2.75	2.25	2.58	1.83
3	.....	2.67	2.58	2.08	2.50	1.67
4	.....	2.67	2.67	2.00	2.50	1.67
5	.....	2.67	(a)	2.00	2.50	1.67
6	.....	2.67	(a)	2.17	2.50	1.67
7	.....	2.67	(a)	2.33	2.67	1.58
8	.....	2.67	(a)	2.33	2.67	1.50
9	.....	2.58	1.25	2.42	2.67	1.50
10	.....	2.50	2.42	2.33	2.67	1.67
11	.....	2.50	2.42	2.25	2.25	1.17
12	.....	2.50	2.33	2.17	2.25	1.17
13	.....	2.33	2.17	2.67	2.08	1.17
14	.....	2.33	1.83	2.83	2.08	1.17
15	.....	2.17	1.67	2.83	2.00	1.17
16	.....	2.25	1.83	2.83	2.00	1.17
17	.....	2.33	1.83	2.75	2.08	1.08
18	0.42	2.33	1.75	2.67	2.00	1.00
19	.33	2.33	1.92	2.67	2.00	1.00
20	2.33	2.33	1.83	2.67	2.00	.....
21	2.83	2.42	2.00	2.58	2.00	.....
22	3.00	2.42	2.33	2.50	2.00	.....
23	2.83	2.42	2.50	2.67	2.00	.....
24	2 50	2 42	2.33	2.67	1.92	.....
25	2.50	2.50	2.17	2.67	1.83	.....
26	2.67	2.50	2.17	2.67	1.83	.....
27	2.58	2.50	2.25	2.67	1.83	.....
28	2.58	2.67	2.25	2.75	1.83	.....
29	2.58	2.75	2.08	2.58	1.83	.....
30	2.67	2.83	2.00	2.58	1.83	.....
31	2.50	.....	2.17	2.58	.....	.....

a Water shut off.

Mean daily discharge, in second-feet, of Wapatox canal near North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	41	45	31	39	21
2	.....	41	43	31	39	21
3	.....	41	39	27	37	18
4	.....	41	41	25	37	18
5	.....	41	0	25	37	18
6	.....	41	0	29	37	18
7	.....	41	0	33	41	15
8	.....	41	0	33	41	14
9	.....	39	10	35	41	14
10	.....	37	35	33	41	18
11	.....	37	35	31	31	9
12	.....	37	33	29	31	9
13	.....	33	29	41	27	9
14	.....	33	21	45	27	9
15	.....	29	18	45	25	9
16	.....	31	21	45	25	9
17	.....	33	21	43	27	8

Mean daily discharge, in second-feet, of Wapatox canal near North Yakima, Wash., for 1904—Continued.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
18	1	33	19	41	25	7
19	1	33	23	41	25	7
20	33	33	21	41	25	.....
21	45	35	25	39	25	.....
22	49	35	33	37	25	.....
23	45	35	37	41	25	.....
24	37	35	33	41	23	.....
25	37	37	29	41	21	.....
26	41	37	29	41	21	.....
27	39	37	31	41	21	.....
28	39	41	31	43	21	.....
29	39	43	27	39	21	.....
30	41	45	25	39	21	.....
31	37	.....	29	39	.....	.....

Estimated monthly discharge of Wapatox canal near North Yakima, Wash., for 1904.

[Irrigated area, 1,400 acres.]

Month.	Discharge in second-feet.			Total in acre-feet.	Depth of run-off in inches, over irrigated area.
	Maximum.	Minimum.	Mean.		
April 16–30 [a]	.....	.....	20.0	595	5.10
May	.....	.....	40.0	2,460	21.1
June	45	29	37.2	2,214	19.0
July [b]	45	10	29.0	1,553	13.3
August	45	25	37.0	2,275	19.5
September	41	21	26.1	1,553	13.3
October 1–15	21	9	14.8	440	3.77
The period	45	9	31.2	11,090	95.1

[a] Estimated April 15–May 17. [b] Water shut off four days.

SMALL CANALS.

Below the Wapatox and above the Yakima Valley canal a group of small canals take water from both banks of Naches River. They are the Cox, Upper Scott, Lower Scott, Fortune, and Laswell canals on the right bank, and the Clark, Lowery, and Kelly canals on the left bank.

Below the intake of the Yakima Valley canal and above Cowiche Creek six more small ditches head into Naches River, namely: The Morrissey, White and Leach, McCormick, and Shearer and Chapman ditches on the left bank, and the two Rhodenbach Schuler ditches on the right bank.

For data concerning these canals see tables on pages 167–169.

GLEED CANAL NEAR NORTH YAKIMA, WASH.

This is the next large canal below the Wapatox. It is owned by the Naches Canal Company. Its intake is on the left bank of the Naches River about 11 miles from North Yakima in sec. 24, T. 14 N., R. 17 E. Just below the head-gates and below the rating station the canal forks. The lower lateral is owned by an association of farmers who irrigate 400 acres from it, and help maintain the main canal above the fork. This 400 acres is not included in the 1,400 irrigated by the Gleed canal.

Discharge measurements of Gleed canal near North Yakima, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq.-feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 19	G. F. Harley	14	39	1.96	2.41	74
July 9	do	14	23	1.09	1.08	25
August 30	J. C. Dry	14	35	1.40	2.04	49

Mean daily gage height, in feet, of Gleed canal near North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1		2.00	2.58	2.50	2.17	1.33
2		2.33	2.58	2.50	2.17	1.33
3		2.33	2.58	2.50	2.08	1.33
4		2.33	2.58	2.50	2.08	
5		2.33	1.00	2.50	2.00	
6		2.25	1.17	2.50	1.83	
7		2.25	1.33	2.42	1.83	
8		2.33	1.33	2.42	2.00	
9		2.33	1.33	2.50	2.00	
10		2.25	1.17	2.42	2.00	
11		2.25	1.08	2.42	2.00	
12		2.17	1.67	2.42	1.75	
13		2.25	1.83	2.42	1.75	
14		2.25	1.83	2.42	1.75	
15		2.25	1.83	2.42	1.50	
16		2.17	1.83	2.42	1.50	
17		2.17	1.83	2.42	1.33	
18		2.33	1.75	2.33	1.33	
19	2.42	1.83	1.92	2.33	1.33	
20	2.50	1.83	2.00	2.33	1.33	
21	2.58	2.00	2.00	2.25	1.33	
22	2.67	2.00	2.25	2.21	1.33	
23	2.00	2.00	2.25	2.17	1.33	
24	2.25	2.00	2.33	2.17	1.33	
25	2.17	1.83	2.33	2.17	1.33	
26	2.33	1.67	2.50	2.17	1.33	
27	2.33	1.67	2.50	2.08	1.33	
28	2.42	2.25	2.50	2.08	1.33	
29	1.00	2.50	2.50	2.00	1.33	
30	1.00	2.58	2.50	2.00	1.33	
31	2.50		2.50	2.17		

Mean daily discharge, in second-feet, of Gleed canal near North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	52	86	80	59	28
2	.....	71	86	80	59	28
3	.....	71	86	80	56	28
4	.....	71	86	80	56	.....
5	.....	71	21	80	52	.....
6	.....	65	24	80	46	.....
7	.....	65	28	74	46	.....
8	.....	71	28	74	52	.....
9	.....	71	28	80	52	.....
10	.....	65	24	74	52	.....
11	.....	65	23	74	52	.....
12	.....	59	38	74	42	.....
13	.....	65	46	74	42	.....
14	.....	65	46	74	42	.....
15	.....	65	46	74	32	.....
16	.....	59	46	74	32	.....
17	.....	59	46	74	28	.....
18	.....	71	42	71	28	.....
19	74	46	48	71	28	.....
20	80	46	52	71	28	.....
21	86	52	52	65	28	.....
22	89	52	65	62	28	.....
23	52	52	65	59	28	.....
24	65	52	71	59	28	.....
25	59	46	71	59	28	.....
26	71	38	80	59	28	.....
27	71	38	80	56	28	.....
28	74	65	80	56	28	.....
29	21	80	80	52	28	.....
30	21	86	80	52	28	.....
31	80	.....	80	59	.....	.....

Rating table for Gleed canal near North Yakima, Wash., from May 19 to October 3, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.00	21	1.45	30	1.90	48	2.35	71
1.05	22	1.50	32	1.95	50	2.40	74
1.10	23	1.55	34	2.00	52	2.45	77
1.15	24	1.60	36	2.05	54	2.50	80
1.20	25	1.65	38	2.10	56	2.55	83
1.25	26	1.70	40	2.15	59	2.60	86
1.30	27	1.75	42	2.20	62	2.65	89
1.35	28	1.80	44	2.25	65	2.70	92
1.40	29	1.85	46	2.30	68	2.75	95

The above table is based upon 3 discharge measurements made during 1904. It is well defined between gage heights 1.00 foot and 2.50 feet.

Estimated monthly discharge of Gleed canal near North Yakima, Wash., for 1904.

[Irrigated area, 1,800 acres [a].]

Month.	Discharge in second-feet.			Total in acre-feet.	Depth of run-off in inches over irrigated area.
	Maximum.	Minimum.	Mean.		
April 16–30 [b]			40.0	1,190	7.94
May			65.0	3,997	26.6
June	86	38	61.1	3,636	24.2
July	86	21	55.9	3,437	22.9
August	80	52	69.4	4,267	28.4
September	59	28	38.8	2,309	15.4
October 1–15 [c]			28.0	833	5.55
The period	86	21	54.2	19,670	131.0

[a] Includes 400 acres under the lower lateral.
[b] Estimated April 15–May 18.
[c] Estimated September 4–15.

YAKIMA VALLEY CANAL NEAR NORTH YAKIMA, WASH.

This canal heads in the right bank of the Naches River about three-fourths mile below the intake of the Gleed canal in sec. 24, T. 14 N., R. 17 E. It extends by flume to Cowiche Creek, which is crossed by an inverted siphon of two pipes. It irrigates land north and west of North Yakima. The canal is the property of a cooperative company of 4,200 shares, or 1 share for each acre under the canal.

Discharge measurements of Yakima Valley canal near North Yakima, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 14	G. H. Bliss	9	20.2	2.55	1.71	51.4
June 30	G. F. Harley	9	15.9	2.42	1.37	38.5
July 20	J. C. Dry	9	19.6	3.11	1.92	61.1
August 13	G. F. Harley	9	23.3	3.29	2.13	79.0

Mean daily gage height, in feet, of Yakima Valley canal near North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	1.60	1.81	1.92	2.00	2.12	1.64
2	1.58	1.81	1.92	2.04	2.10	1.64
3	1.56	1.83	1.92	2.04	2.08	1.64
4	1.37	1.83	1.87	2.08	2.04	1.64
5	1.39	1.83	1.87	2.08	2.00	1.62
6	1.25	1.83	(a)	2.08	2.00	1.50
7	1.08	1.79	(a)	2.08	2.00	1.50
8	1.04	1.79	(a)	2.08	2.00	1.48

[a] Water shut off.

Mean daily gage height, in feet, of Yakima Valley canal near North Yakima, Wash., for 1904—Continued.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
9	1.33	1.75	1.71	2.08	2.00	1.33
10	1.54	1.73	1.75	2.12	2.00	1.33
11	1.56	1.71	1.75	2.08	2.00	1.50
12	1.60	1.71	1.92	2.12	2.00	1.48
13	1.62	1.71	1.96	2.12	1.87	1.48
14	1.71	1.67	1.92	2.12	1.87	1.46
15	1.71	1.67	1.92	2.12	1.87	1.25
16	1.71	1.67	1.92	2.12	1.83	.....
17	1.71	1.67	1.92	2.12	1.83	.....
18	1.71	1.67	1.92	2.12	1.83	.....
19	1.71	1.69	1.92	2.12	1.83	.....
20	1.69	1.75	1.92	2.12	1.83	.....
21	1.71	1.77	1.92	2.12	1.83	.....
22	1.67	1.79	1.92	2.12	1.83	.....
23	1.67	1.83	1.96	2.12	1.83	.....
24	1.71	1.85	1.96	2.14	1.83	.....
25	1.33	1.87	1.96	2.17	1.79	.....
26	1.71	1.92	1.96	2.17	1.79	.....
27	1.75	1.92	2.00	2.17	1.79	.....
28	1.75	1.94	2.00	2.17	.83	.....
29	1.79	1.92	2.00	2.17	.83	.....
30	1.81	(a)	2.00	2.17	.83	.....
31	1.79	.....	2.00	2.14	.....	.....

[a] Water shut off.

Mean daily discharge, in second-feet, of Yakima Valley canal near North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	47	56	62	69	77	49
2	47	56	62	73	77	49
3	45	59	62	73	77	49
4	37	59	59	77	73	49
5	39	59	59	77	69	47
6	35	59	0	77	69	43
7	31	56	0	77	69	43
8	30	56	0	77	69	43
9	37	53	51	77	69	37
10	45	53	53	77	69	37
11	45	51	53	77	69	43
12	47	51	62	77	69	43
13	47	51	65	77	59	43
14	51	49	62	77	59	41
15	51	49	62	77	59	35
16	51	49	62	77	59	.....
17	51	49	62	77	59	.....
18	51	49	62	77	59	.....
19	51	51	62	77	59	.....
20	51	53	62	77	59	.....
21	51	53	62	77	59	.....
22	49	56	62	77	59	.....
23	49	59	65	77	59	.....
24	51	59	65	81	59	.....

Mean daily discharge, in second-feet, of Yakima Valley canal near North Yakima, Wash., for 1904—Continued.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
25	37	59	65	81	56	.....
26	51	62	65	81	59	.....
27	53	62	69	81	59	.....
28	53	65	69	81	29	.....
29	56	62	69	81	29	.....
30	56	0	69	81	29	.....
31	56	.....	69	81	.....	.....

Rating table for Yakima Valley canal near North Yakima, Wash., from May 1 to October 15, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.85	28.5	1.25	35	1.65	49	2.00	69
90	29	1.30	36	1.70	51	2.05	73
95	29.5	1.35	37	1.75	53	2.10	77
1.00	30	1.40	39	1.80	56	2.15	81
1.05	31	1.45	41	1.85	59	2.20	86
1.10	32	1.50	43	1.90	62	2.25	91
1.15	33	1.55	45	1.95	65	2.30	96
1.20	34	1.60	47				

The above table is based upon 4 discharge measurements made during 1904. It is well defined between gage heights 1.35 feet and 2.15 feet. The table has been extended beyond these limits.

Estimated monthly discharge of Yakima Valley canal near North Yakima, Wash., for 1904.

[Irrigation area, 3,600 acres.]

Month.	Discharge in second-feet.			Total in acre-feet.	Depth of run-off in inches, over irrigated area.
	Maximum.	Minimum.	Mean.		
April 16–30[a]	.....	.....	40.0	1,190	3.97
May	56	30	46.8	2,878	9.59
June[b]	65	49	55.3	3,181	10.6
July[c]	69	51	62.5	3,471	11.6
August	81	69	77.5	4,765	15.9
September	77	29	60.8	3,618	12.1
October 1–15	49	35	43.4	1,291	4.30
The period	81	30	57.4	20,390	68.1

[a] Estimated. [b] Water shut off 1 day. [c] Water shut off 3 days.

NACHES-COWICHE CANAL NEAR NORTH YAKIMA, WASH.

The intake of this canal is on the right bank of the river just below Nelson's bridge at Painted Rocks, in sec. 9, T. 13 N., R. 18 E. About one-half mile below the intake the canal crosses Cowiche Creek and until about the middle of June takes nearly all its water from this source. The amount of water taken from the river gradually increases until about the 1st of August, after which date the entire flow of the canal is drawn from Naches River.

Discharge measurements of Naches-Cowiche canal near North Yakima, Wash., in 1904.

Date.	Hydrographer	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec. feet.*
May 4	G. F. Harley	8	15	2.13	2.63	32
May 14	G. H. Bliss	8	22	2.00	3.20	44
July 12	do	8	21	1.93	3.12	41
August 12	J. C. Dry	8	24	1.96	3.30	46

Mean daily gage height, in feet, of Naches-Cowiche canal near North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	3.12	2.96	3.08	2.83	1.50
2	.....	3.12	3.00	1.02	2.83	1.50
3	.....	3.08	3.04	3.75	2.79	1.50
4	.....	3.15	3.04	3.92	2.79	1.50
5	.....	3.08	3.04	3.92	2.71	1.50
6	3.08	3.00	3.04	3.83	2.71	1.67
7	3.08	3.00	3.04	3.92	2.71	1.67
8	3.08	2.96	3.04	3.92	2.71	1.67
9	3.12	2.96	3.17	3.92	2.71	1.67
10	3.17	2.87	3.04	3.83	2.62	1.50
11	3.17	2.83	3.08	3.83	2.62	.....
12	3.17	2.75	3.17	3.92	2.62	.....
13	3.17	2.62	3.17	3.92	2.62	.....
14	3.21	2.50	3.17	3.92	2.45	.....
15	3.21	2.50	3.17	3.92	2.50	.....
16	3.04	2.50	3.17	3.92	2.50	.....
17	3.12	2.87	3.17	3.17	2.25	.....
18	3.12	3.12	3.17	3.17	2.12	.....
19	3.12	3.12	2.75	3.17	2.17	.....
20	3.17	3.17	2.75	3.21	2.17	.....
21	3.17	3.17	2.62	3.17	1.92	.....
22	3.17	3.17	2.62	3.17	1.92	.....
23	3.21	3.04	2.83	3.21	1.92	.....
24	3.17	3.04	2.83	3.17	1.92	.....
25	3.12	3.17	2.92	3.12	1.92	.....
26	3.15	3.17	2.92	3.12	1.50	.....
27	3.12	3.17	2.96	3.12	1.50	.....
28	3.17	3.17	2.96	3.12	1.50	.....
29	3.17	3.21	2.96	3.12	1.50	.....
30	3.17	3.25	3.08	3.08	1.50	.....
31	3.17	.....	3.08	3.12	.....	.....

Mean daily discharge, in second-feet, of Naches-Cowiche canal near North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	41	38	41	36	24
2	.....	41	39	23	36	24
3	.....	41	40	64	35	24
4	.....	41	40	70	35	24
5	.....	41	40	70	33	24
6	41	39	40	68	33	24
7	41	39	40	70	33	25
8	41	38	40	70	33	24
9	41	38	42	70	33	25
10	42	36	40	68	31	24
11	42	36	41	68	31	.....
12	42	34	42	70	31	.....
13	42	31	42	70	31	.....
14	44	30	42	70	30	.....
15	44	30	42	70	30	.....
16	40	30	42	70	30	.....
17	41	36	42	42	28	.....
18	41	41	42	42	26	.....
19	41	41	34	42	27	.....
20	42	42	34	44	27	.....
21	42	42	31	42	25	.....
22	42	42	31	42	25	.....
23	44	40	36	44	25	.....
24	42	40	36	42	25	.....
25	41	42	37	41	25	.....
26	42	42	37	41	24	.....
27	41	42	38	41	24	.....
28	42	42	38	41	24	.....
29	42	44	38	41	24	.....
30	42	45	41	41	24	.....
31	42	.....	41	41	.....	.....

Rating table for Naches-Cowiche canal near North Yakima, Wash., from May 6 to October 10, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.00	25.8	2.50	30.0	3.00	39	3.50	54
2.05	26.0	2.55	30.5	3.05	40	3.55	56
2.10	26.2	2.60	31	3.10	41	3.60	58
2.15	26.5	2.65	32	3.15	42	3.65	60
2.20	27.0	2.70	33	3.20	43	3.70	62
2.25	27.5	2.75	34	3.25	44	3.75	64
2.30	28.0	2.80	35	3.30	46	3.80	66
2.35	28.5	2.85	36	3.35	48	3.85	68
2.40	29.0	2.90	37	3.40	50	3.90	70
2.45	29.5	2.95	38	3.45	52	3.95	72

The preceding table is based upon 4 discharge measurements made during 1904. It is well defined between gage heights 2.60 feet and 3.30 feet. The table has been extended beyond these limits.

Estimated monthly discharge of Naches-Cowiche canal near North Yakima, Wash., for 1904.

[Irrigated area, 1,500 acres.]

Month.	Discharge in second-feet.			Total in acre-feet.	Depth of run-off in inches, over irrigated area.
	Maximum.	Minimum.	Mean.		
April 16–30 [a]	.....	.....	30.0	893	7.14
May	44	40	42.0	2,582	20.6
June	45	30	38.9	2,315	18.5
July	42	31	38.9	2,392	19.1
August	70	23	53.5	3,290	26.3
September	36	24	29.1	1,732	13.9
October 1–15 [b]	24	24	24.0	714	5.71
The period	70	23	38.4	13,920	111.2

[a] Estimated April 16 to May 5. [b] Estimated October 10–15.

BROADGAUGE CANAL NEAR NORTH YAKIMA, WASH.

This canal heads in a slough on the right bank of the river in sec. 10, T. 13 N., R. 18 E. About 3 miles below the intake it crosses the wasteway of the Power canal and draws from it the entire flow which it carries beyond this point The Broadgauge canal is now the property of the Northwestern Light and Water Company.

Discharge measurements of Broadgauge canal near North Yakima, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 4 [a]	G. F. Harley	10	11.0	0.50	2.42	5.1
June 16 [a]	G. H. Bliss	10	9.5	.25	2.25	2.4
June 30 [b]	J. C. Dry	6	11.7	1.36	1.19	15.9
July 16 [b]	do	6	11.6	1.41	1.15	16.3
September 15 [b]	do	6	5.7	.89	.22	5.1

[a] Measured at headworks. [b] Measured below Power canal.

Mean daily gage height, in feet, of Broadgauge canal near North Yakima, Wash., for 1904.

Day.	May.	June.	Day.	May.	June.	Day.	May.	June.
1		2.42	12		2.25	22	2.58	2.50
2		2.42	13		2.25	23	2.49	2.50
3		2.45	14		2.17	24	2.42	2.33
4		2.42	15		2.17	25	2.42	2.33
5		2.42	16		2.25	26	2.42	2.33
6		2.42	17	2.42	2.42	27	2.42	2.25
7		2.37	18	2.50	2.42	28	2.46	2.25
8		2.33	19	2.50	2.82	29	2.42	2.50
9		2.25	20	2.62	2.50	30	2.73	2.50
10		2.25	21	2.67	2.50	31	2.71	
11		2.25						

Mean daily discharge, in second-feet, of Broadgauge canal near North Yakima, Wash., for 1904.

Day.	May.	June.	Day.	May.	June.	Day.	May.	June.
1		5.0	12		2.5	22	5.5	5.5
2		5.0	13		2.5	23	5.5	5.5
3		5.0	14		2.0	24	5.0	4.5
4		5.0	15		2.0	25	5.0	4.5
5		5.0	16		2.5	26	5.0	4.5
6		5.0	17	5.0	5.0	27	5.0	2.5
7		4.5	18	5.5	5.0	28	5.0	2.5
8		4.5	19	5.5	7.0	29	5.0	5.5
9		2.5	20	6.0	5.5	30	6.5	5.5
10		2.5	21	6.0	5.5	31	6.5	
11		2.5						

Estimated monthly discharge of Broadgauge canal near North Yakima, Wash., for 1904.

[Irrigated area, 500 acres.]

Month.	Discharge in second-feet.	Total in acre-feet.	Depth of run-off in inches, over irrigated area.
April 16–30	4.0	119	2.86
May	5.5	338	8.11
June [a]	17.0	1,012	24.3
July [b]	15.9	978	23.5
August [b]	16.3	1,002	24.0
September [b]	10.0	595	14.3
October 1–15 [b]	8.0	238	5.71
The period	11.8	4,282	102.8

[a] Partly from the Power canal. [b] Taken from the Power canal.

POWER CANAL AT NORTH YAKIMA, WASH.

This canal heads in the river on its right bank in sec. 10, T. 13 N., R. 18 E. Previous to October, 1904, it was known as the Yakima Valley Light and Power Company canal. It is now the property of the Northwestern Light and Water Company, and is the largest canal taking water from Naches River. The new company now controls also the Shanno and Broadgauge canals. These two canals and the Union canal cross the Power canal, and during the summer are supplied chiefly by it. Only 250 acres are irrigated from the Power canal. It is used mainly for power purposes, and all of its flow not withdrawn by other canals is spilled into the Yakima River. The wastage is very regular in amount as shown by measurements of the wasteway.

Discharge measurements of Power canal at North Yakima, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec. feet.*
May 5 [a]	G. F. Harley	25	63	2.83	2.71	178
June 28 [a]	J. C. Dry	25	37	3.11	1.88	116
July 21 [b]	do	25	38	3.26	2.05	124
August 10 [b]	do	25	68	2.88	2.79	196
September 12 [b]	do	25	42	3.22	2.15	134
September 14 [b]	do	25	43	2.98	2.17	128

[a] Measured at the regulating gates.
[b] Measured on the wasteway near the Yakima River; average waste 125 second-feet.

Mean daily gage height, in feet, of Power canal at North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	2.67	2.71	2.75	2.79	2.79
2	.....	2.71	2.71	2.75	2.75	2.79
3	.....	2.71	2.67	2.75	2.83	2.79
4	.....	2.75	2.67	2.75	2.83	2.79
5	2.71	2.75	2.71	2.75	2.83	2.79
6	2.71	2.58	2.67	2.75	2.87	2.79
7	2.79	2.58	2.71	2.75	2.79	2.83
8	2.83	2.71	2.67	2.71	2.83	2.83
9	2.71	2.67	2.62	2.67	2.79	2.75
10	2.67	2.67	2.71	2.75	2.79	2.75
11	2.71	2.67	2.67	2.75	2.79	2.87
12	2.67	2.67	2.67	2.62	2.79	2.83
13	2.67	2.71	2.62	2.79	2.79	.....
14	2.71	2.71	2.67	2.79	2.79	.....
15	2.67	2.75	2.71	2.79	2.83	.....
16	2.67	2.71	2.67	2.75	2.79	.....
17	2.67	2.67	2.67	2.75	2.79	.....
18	2.71	2.67	2.79	2.71	2.79	.....
19	2.71	2.71	2.75	2.75	2.75	.....

Mean daily gage height, in feet, of Power canal at North Yakima, Wash., for 1904—Cont'd.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
20	2.71	2.62	2.75	2.75	2.83	.....
21	2.67	2.75	2.75	2.75	2.79	.....
22	2.62	2.67	2.71	2.79	2.83	.....
23	2.50	2.67	2.79	2.75	2.79	.....
24	2.67	2.71	2.67	2.71	2.83	.....
25	2.67	2.75	2.71	2.75	2.79	.....
26	2.67	2.71	2.75	2.71	2.87	.....
27	2.67	2.71	2.67	2.75	2.87	.....
28	2.67	2.75	2.75	2.79	2.87	.....
29	2.62	2.75	2.75	2.79	2.87	.....
30	2.67	2.79	2.83	2.67	2.87	.....
31	2.71	.....	2.83	2.67	.....	.....

Mean daily discharge, in second-feet, of Power canal at North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	172	178	187	196	196
2	.....	178	178	187	187	196
3	.....	178	172	187	198	196
4	.....	187	172	187	198	196
5	178	187	178	187	198	196
6	178	160	172	187	210	196
7	196	160	178	187	196	198
8	198	178	172	178	198	198
9	178	172	165	172	196	187
10	172	172	178	187	196	187
11	178	172	172	187	196	210
12	172	172	172	165	196	198
13	172	178	165	196	196	.....
14	178	178	172	196	196	.....
15	172	187	178	196	198	.....
16	172	178	172	187	196	.....
17	172	172	172	187	196	.....
18	178	172	196	178	196	.....
19	178	178	187	187	187	.....
20	178	172	187	187	198	.....
21	172	187	187	187	196	.....
22	165	172	178	196	198	.....
23	150	172	196	187	196	.....
24	172	178	172	178	198	.....
25	172	187	178	187	196	.....
26	172	178	187	178	210	.....
27	172	178	172	187	210	.....
28	172	187	187	196	210	.....
29	172	187	187	196	210	.....
30	172	196	198	172	210	.....
31	178	.....	198	172	.....	.....

Estimated monthly discharge of Power canal at North Yakima, Wash., for 1904.

[Irrigated area, 250 acres.]

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April 16–30 [a]			170	5,058
May	198	150	174	10,700
June	196	160	178	10,590
July	198	165	176	10,820
August	196	165	189	11,620
September	210	187	199	11,840
October 1–15 [b]	210	187	196	5,831
The period	210	150	183	66,460
Wasted into Yakima River			125	45,370
Used for irrigation and supplied to other canals			58	21,090

[a] Estimated April 15 to May 4. [b] Estimated October 13–15.

SHANNO CANAL AT NORTH YAKIMA, WASH.

This canal heads in Naches River on the right bank in sec. 11, T. 13 N., R. 18 E., in sec. 13. It crosses the Power canal and receives from it all the water carried beyond this point. The headworks of this canal were washed away during 1904, and in October, 1904, it became the property of the Northwestern Light and Water Company.

Discharge measurements of Shanno canal at North Yakima, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec. feet.*
May 5 [a]	G. F. Harley	9	13.0	1.77	1.19	23
June 16 [a]	G. H. Bliss	12	25.0	2.20	2.21	55
June 30 [a]	J. C. Dry	9	17.8	1.54	1.88	27
July 12 [b]	do	9	13.8	.74	.88	10
August 12 [b]	do	9	21.0	1.43	2.12	30
September 15 [b]	do	9	19.5	1.00	2.05	19

[a] Measured at the headworks. [b] Measured below the Power canal.

Mean daily gage height, in feet, of Shanno canal at North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Day.	May.	June.	July.	Day.	May.	June.	July.
1		.92	2.17	12	1.21	.92	.....	22	1.46	1.62	.....
2		.87	1.96	13	1.25	.75	.....	23	1.46	1.00	.....
3	1.17	1.08	1.96	14	1.33	1.33	.....	24	1.50	(a)	.....
4	1.29	1.17	2.17	15	1.50	1.67	.....	25	1.25	.50	.....
5	1.25	1.50	2.17	16	1.46	2.17	.....	26	1.08	.50	.....
6	1.18	2.04	1.83	17	1.50	2.33	.....	27	.92	1.42	.....
7	1.17	1.67	1.62	18	1.25	2.83	.....	28	1.00	1.50	.....
8	1.17	.67	1.58	19	.92	2.62	.....	29	1.04	1.67	.....
9	1.08	.67	1.25	20	.92	2.04	.....	30	1.12	2.00	.....
10	1.12	.67	.83	21	1.04	1.67	.....	31	.83	.....	.....
11	1.12	(a)	.....								

a Water shut off.

Mean daily discharge, in second-feet, of Shanno canal at North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Day.	May.	June.	July.	Day.	May.	June.	July.
1		12	53	12	21	12	.....	22	30	36	.....
2		10	46	13	23	8	.....	23	30	15	.....
3	20	18	46	14	24	25	.....	24	31	0	.....
4	24	20	53	15	31	33	.....	25	23	3	.....
5	22	31	53	16	30	54	.....	26	17	3	.....
6	20	48	42	17	31	59	.....	27	13	28	.....
7	20	36	34	18	23	75	.....	28	15	31	.....
8	20	6	34	19	12	69	.....	29	16	36	.....
9	17	6	23	20	12	49	.....	30	18	48	.....
10	18	6	10	21	16	37	.....	31	10	.....	.....
11	18	0	.....								

Rating table for Shanno canal at North Yakima, Wash., from May 3 to July 10, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.35	0.0	1.00	14.8	1.65	36.1	2.30	58.2
.40	1.0	1.05	16.4	1.70	37.8	2.35	59.9
.45	2.0	1.10	18.0	1.75	39.5	2.40	61.6
.50	3.0	1.15	19.6	1.80	41.2	2.45	63.3
.55	4.0	1.20	21.2	1.85	42.9	2.50	65.0
.60	5.0	1.25	22.9	1.90	44.6	2.55	66.7
.65	6.0	1.30	24.6	1.95	46.3	2.60	68.4
.70	7.0	1.35	26.2	2.00	48.0	2.65	70.1
.75	8.0	1.40	27.8	2.05	49.7	2.70	71.8
.80	9.0	1.45	29.5	2.10	51.4	2.75	72.5
.85	10.0	1.50	31.2	2.15	53.1	2.80	74.2
.90	11.6	1.55	32.8	2.20	54.8	2.85	75.9
.95	13.2	1.60	34.4	2.25	56.5		

The preceding table is based upon 3 discharge measurements made in 1904. It is well defined between gage heights 0.80 foot and 2.20 feet. The table has been extended beyond these limits.

Estimated monthly discharge of Shanno canal at North Yakima, Wash., for 1904.

[Irrigated area, 1,000 acres.]

Month.	Discharge in second-feet.			Total in acre-feet.	Depth of run-off in inches, over irrigated area.
	Maximum.	Minimum.	Mean.		
April 16-30 [a]			20.0	595	7.14
May	31	10	21.0	1,291	15.5
June [b]	75	2	29.1	1,616	19.4
July [c]	53	10	30.0	1,845	22.1
August			30.0	1,845	22.1
September			19.0	1,131	13.6
October 1-15			15.0	446	5.35
The period	75	2	24.4	8,769	105.2

[a] Estimated April 16 to May 2. [b] Water shut off two days. [c] After July 10 supplied by Power canal.

UNION CANAL AT NORTH YAKIMA, WASH.

This canal heads in Naches River in two places about one-half mile apart on the right bank in sec. 11, T. 13 N., R. 18 E. It is a very old canal, having first taken water from the Naches River in 1869. No appropriation was ever made for it, but the Union Canal Company agree to supply 3,000 miner's inches to its shareholders and 40 inches to private parties. The two branches unite about three-fourths mile below the upper headworks. In section 13 the Union canal crosses the wasteway of the Power canal and takes some additional water from it. From the Power canal to a point on Naches avenue, in sec. 18, T. 13 N., R. 19 E., a distance of about a mile, it is known as the Mill ditch. Here it leaves the Mill ditch, taking about half its flow, and continues south along Naches avenue. The water remaining in the Mill ditch is returned to the wasteway of the Power canal. The Union canal spills into Yakima River in sec. 32, T. 13 N., R. 19 E. Its waste here is about 1.5 per cent of the water taken in at the head-gates. The town of North Yakima uses water from this canal for the irrigation of shade trees.

Discharge measurements of Union canal at upper head works, at North Yakima, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 5	G. F. Harley	8	7.2	2.10	0.83	15.2
May 6	G. H. Bliss	8	8.0	2.04	.92	16.4
June 16	do	6	5.2	.72	.42	3.8
July 12	do	6	2.8	1.00	.33	2.8

Mean daily gage height, in feet, of Union canal at upper head works, at North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept	Day.	May.	June.	July.	Aug.	Sept.
1		0.33	0.67	0.17	0.25	17	0.50	0.42	0.17	0.50	.....
2		.33	.58	.17	.33	18	.50	.42	(a)	.42	.....
3	0.83	.33	.67	.33	.25	19	.42	.42	(a)	.42	.....
4	.92	.33	.71	.17	.17	20	.33	.37	(a)	.42	.....
5	1.00	.33	.50	.17	.08	21	.42	.42	.17	.37	.....
6	1.00	.33	.50	.17	.08	22	.25	.46	.50	.25	.....
7	(a)	.29	.46	.17	.08	23	.25	.42	.33	.25	.....
8	.50	.33	.42	.17	.12	24	.33	.37	.25	.17	.....
9	.50	.33	.33	.42	.08	25	.25	.37	(a)	.17	.....
10	.42	.33	.42	.33	.08	26	.33	.37	(a)	(a)	.....
11	.42	.50	.37	.17	.....	27	.42	.50	.33	.17	.....
12	1.25	.50	.25	.17	.....	28	.33	.50	.17	.25	.....
13	.50	.58	.25	.17	.....	29	.33	.50	.08	.58	.....
14	.50	.58	(a)	.12	.....	30	.42	.58	.17	.58	.....
15	.50	.58	(a)	.08	.....	31	.33	.....	.17	.37	.....
16	.50	.79	(a)	.50	.....						

a Water shut off.

Mean daily discharge, in second-feet, of Union canal at upper head works, at North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Day.	May.	June.	July.	Aug.	Sept.
1		3	9	1	2	17	5	4	1	4	.....
2		3	6	1	3	18	5	4	0	4	.....
3	15	3	9	3	2	19	4	4	0	4	.....
4	16	3	9	1	1	20	3	3	0	3	.....
5	22	3	5	1	.5	21	4	4	1	2	.....
6	22	3	5	1	.5	22	2	5	5	2	.....
7	0	2	4	1	.5	23	2	4	3	1	.....
8	5	3	4	1	1	24	3	3	2	1	.....
9	5	3	3	4	.5	25	2	3	0	0	.....
10	4	3	4	3	.5	26	3	3	0	1	.....
11	4	5	3	1	.....	27	4	5	3	2	.....
12	35	5	2	1	.....	28	3	5	1	7	.....
13	5	6	2	1	.....	29	3	5	.5	7	.....
14	5	6	0	1	.....	30	4	6	1	3	.....
15	5	6	0	0.5	.....	31	3	.....	1	.....	.....
16	5	14	0	5	.....						

Discharge measurements of Union canal at lower head works, at North Yakima, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec. feet.*
June 16 [a]	G. H. Bliss	13	17.6	2.27	1.92	40.0
July 12 [a]	do	13	19.0	1.71	1.70	32.5
August 12 [a]	J. C. Dry	13	20.4	1.89	2.04	38.5
June 28 [b]	do	10	23.0	1.84	2.02	42.4
July 16 [b]	do	10	23.4	1.70	1.92	39.4
September 14 [b]	do	10	21.1	1.63	1.80	34.5

[a] At the headworks. [b] Below the mill ditch.

Mean daily gage height, in feet, of Union canal at lower head works, at North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Day.	May.	June.	July.	Aug.	Sept.
1	.....	1.92	1.92	1.50	1.67	17	2.00	2.00	1.67	1.92	1.50
2	.....	1.83	1.92	1.58	1.67	18	1.83	2.08	1.67	1.83	1.50
3	.....	1.92	2.00	2.08	1.67	19	1.92	2.00	1.50	1.67	1.50
4	.....	1.92	2.00	2.00	1.50	20	1.92	1.96	2.33	1.67	1.50
5	.....	1.92	2.00	2.00	1.50	21	2.00	1.83	2.08	1.50	1.42
6	0.67	2.00	1.92	2.00	1.50	22	2.00	1.92	2.00	1.50	1.67
7	1.33	1.83	1.92	2.08	1.67	23	1.92	1.92	1.67	1.50	1.83
8	1.33	1.92	1.83	2.33	1.67	24	1.83	1.67	1.67	1.17	1.83
9	1.42	1.92	1.75	2.17	1.67	25	1.75	1.67	1.67	1.17	1.75
10	1.42	1.67	1.83	2.17	1.67	26	1.83	1.67	1.67	1.00	1.58
11	1.75	1.67	1.83	2.00	1.58	27	1.83	1.83	1.67	1.67	1.67
12	2.00	1.92	1.67	2.17	1.58	28	1.92	2.00	1.67	1.00	1.83
13	1.83	1.92	1.42	1.92	1.00	29	1.92	2.17	1.58	2.00	2.00
14	2.00	2.00	1.33	2.00	1.54	30	1.92	2.08	1.58	1.67	2.17
15	2.08	2.00	1.67	2.00	1.42	31	1.92	.....	1.50	1.83	.....
16	2.00	2.08	1.67	1.92	1.50						

Mean daily discharge, in second-feet, of Union canal at lower head works, at North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Day.	May.	June.	July.	Aug.	Sept.
1	.....	39	39	28	33	17	40	40	33	39	28
2	.....	35	39	28	33	18	35	41	33	35	28
3	.....	39	40	41	33	19	39	40	28	33	28
4	.....	39	40	40	28	20	39	40	47	33	28
5	.....	39	40	40	28	21	40	35	41	28	26
6	9	40	39	40	28	22	40	39	40	28	33
7	24	35	39	41	33	23	39	39	33	28	35
8	24	39	35	47	33	24	35	33	33	20	35
9	26	39	34	43	33	25	34	33	33	20	34
10	26	33	35	43	33	26	35	33	33	16	28
11	34	33	35	41	28	27	35	35	33	33	33
12	40	39	33	43	28	28	39	40	33	16	35
13	35	39	26	39	16	29	39	43	30	40	40
14	40	40	24	40	28	30	39	41	30	33	44
15	41	40	33	40	26	31	39	.....	28	35	.....
16	40	41	33	39	28						

Estimated monthly discharge[a] of Union canal at North Yakima, Wash., for 1904.

[Irrigated area, 2,000 acres.]

Month.	Discharge in second-feet.			Total in acre-feet.	Depth of run-off, in inches, over irrigated area.
	Maximum.	Minimum.	Mean.		
April 16–30[b]			35.0	1,041	6.24
May	46	24	41.7	2,564	15.4
June	53	36	39.0	2,321	13.9
July	50	28	37.3	2,294	13.8
August	48	16	36.9	2,269	13.6
September	36	16	32.0	1,904	11.4
October 1–15[b]			30.0	893	5.35
The period	53	16	36.6	13,290	79.7

[a] Sum of discharge at the two intakes. [b] Estimated.

TOWN CANAL AT NORTH YAKIMA, WASH.

This canal heads in Naches River on the right bank one-eighth mile above the Northern Pacific Railway bridge and three-fourths mile above the mouth of the river. It is the property of the town of North Yakima and is used chiefly for the irrigation of shade trees. It irrigates also about 640 acres of land.

Discharge measurements of Town canal at North Yakima, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 5	G. H. Bliss	8	11.5	1.04	1.83	12,0
July 12	do	8	11.1	1.25	1.85	13.9

Mean daily gage height, in feet, of Town canal at North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1		1.79	2.04	1.92	2.00	2.08
2		1.79	1.96	2.08	2.00	2.00
3		1.75	2.00	1.92	1.92	1.92
4		1.75	2.04	1.83	1.92	1.75
5	1.83	1.92	1.96	2.00	1.87	1.58
6	1.75	2.00	1.92	2.50	1.83	1.50
7	1.67	1.75	1.83	2.33	1.83	1.42
8	1.71	1.58	1.87	2.50	1.75	1.33
9	1.67	1.37	1.71	2.42	1.75	1.25
10	1.62	1.92	1.75	2.37	1.83	
11	1.92	1.75	1.71	2.33	1.83	
12	1.92	1.79	1.67	2.33	1.83	
13	1.92	1.75	1.83	2.33	1.75	
14	2.33	1.83	1.92	2.21	1.75	

Mean daily gage height, in feet, of Town canal at North Yakima, Wash., for 1904—Cont'd.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
15	2.29	1.79	1.79	2.21	1.67	.....
16	2.33	1.96	1.75	2.17	1.62	.....
17	2.33	2.00	1.67	2.17	1.58	.....
18	2.37	2.25	1.50	2.17	1.58	.....
19	2.33	2.08	2.25	2.17	1.58	.....
20	2.29	2.00	2.33	2.12	1.62	.....
21	2.67	2.00	2.33	2.08	1.67	.....
22	2.67	1.96	2.08	2.04	1.75	.....
23	2.67	1.92	2.00	2.00	1.83	.....
24	2.54	1.92	2.00	2.00	1.75	.....
25	2.25	1.92	1.92	1.96	1.67	.....
26	1.92	1.83	1.92	1.87	1.58	.....
27	1.92	2.00	2.21	2.04	1.58	.....
28	1.83	1.87	2.00	2.25	1.67	.....
29	1.92	2.04	1.83	2.17	2.21	.....
30	1.92	2.00	1.67	2.17	2.17	.....
31	1.83	.....	1.50	2.08	.....	.....

Mean daily discharge, in second-feet, of Town canal at North Yakima, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	12	14	13	13	13
2	.....	12	13	14	13	13
3	.....	11	13	13	13	13
4	.....	11	14	12	13	11
5	12	13	13	13	13	9
6	11	13	13	17	12	9
7	10	11	12	16	12	9
8	11	10	13	17	11	8
9	10	8	11	17	11	8
10	10	13	11	16	12	.....
11	13	11	11	16	12	.....
12	13	12	10	16	12	.....
13	13	11	12	16	11	.....
14	16	12	13	15	11	.....
15	15	12	12	15	10	.....
16	16	13	11	15	10	.....
17	16	13	10	15	10	.....
18	16	15	9	15	10	.....
19	16	14	15	15	10	.....
20	15	13	16	14	10	.....
21	20	13	16	13	10	.....
22	20	13	14	13	11	.....
23	20	13	13	13	12	.....
24	20	13	13	13	11	.....
25	15	13	13	13	10	.....
26	13	12	13	12	10	.....
27	13	13	15	13	10	.....
28	12	13	13	15	10	.....
29	13	14	12	15	15	.....
30	13	13	10	15	15	.....
31	12	.....	9	15	.....	.....

Estimated monthly discharge of Town canal at North Yakima, Wash., for 1904.

[Irrigated area, 640 acres.]

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April 16–30[a]			10.0	298
May	20	10	14.0	861
June	15	8	12.3	732
July	16	9	12.5	769
August	17	12	14.5	892
September	15	10	11.4	678
October 1–15[b]	13	8	10.0	298
The period	20	8	12.5	4,528

[a] Estimated April 16 to May 4. [b] Estimated October 10–15.

NORTHWESTERN LIGHT AND WATER COMPANY'S PROPOSED CANAL.

This company, upon October 3, 1904, filed upon 1,000 second-feet of water from Naches River, just below the mouth of Tieton River, on the left or north bank. It is a point in sec. 36, T. 15 N., R. 16 E., which is at the head works of the Wapatox canal.

The company proposes to construct a large canal, the flow of which will be used to generate power. The canal will be 9 miles long and will include the Wapatox canal throughout its length. At the end of the 9 miles all water except that required by the Wapatox canal, will be spilled back into the river at a point just above the intake of the Gleed canal.

CANALS TAKING WATER FROM YAKIMA, TIETON, AND NACHES RIVERS.

Canals taking water from Yakima River.

Canal.	Location.					Length in miles.
	Nearest town.	Head works.			Bank of river.	
		Section.	Township.	Range.		
Below Clealum River and above Naches River.						
Cascade	Thorp		19 N	17 E	Left	42½
West Kittitas	do	33	19 N	17 E	Right	14
Town	Ellensburg	7	18 N	17 E	Left	30
Olsen	do	18	18 N	18 E	do	
Selah-Moxee	North Yakima	8	14 N	19 E	do	27
Taylor	do				Right	4½
Below Naches River and above Atanum Creek.						
Moxee[a]	North Yakima	7	13 N	19 E	Left	8
Hubbard	do	7	13 N	19 E	do	7
Fowler	do	18	13 N	19 E	do	8½
Granger	do	18	13 N	19 E	do	

[a] Contract, 1 second-foot per 160 acres.

Canals taking water from Yakima River—Continued.

Canal.	Location.					Length in miles.
	Nearest town.	Head works.			Bank of river.	
		Section.	Township.	Range.		
Below Atanum Creek.						
New reservation No. 2	Yakima	17	12 N.	19 E.	Right	[a] 4½
Old reservation No. 1	do	28	12 N.	19 E.	do	12½
Government canal No. 3	Toppenish	28	11 N.	20 E.	do	4
Sunnyside [b]	Yakima	28	12 N.	19 E.	Left	38
Gilbert	Toppenish	19	11 N.	20 E.	Right	7
Hatch	do	30	10 N.	21 E.	do	3
Prosser Falls [c]	Prosser				do	10
Ledbetter	do				do	
Kiona [d]	Kiona	10	9 N.	26 E.	Left	9
Kiona Water Supply Co	do				do	
Kennewick [b]	Kennewick	3	10 N.	27 E.	Right	39½
Grosscup's	Kiona	3	10 N.	27 E.	Left	5½

Canal.	Appropriation.		Area under canal.		
	Amount in second-feet.	Date.	Irrigated.	Irrigable.[e]	Proposed extension.
Below Clealum River and above Naches River.			*Acres.*	*Acres.*	*Acres.*
Cascade	[f] 1,000 [g] 500	Nov. 19, 1903 Feb. 28, 1903		16,000	None.
West Kittitas	[h] 10,000	——, 1889	7,000	7,000	None.
Town	None.	[i] Apr. 25, 1889	8,000	10,000	None.
Olsen			1,200	1,200	None.
Selah-Moxee	150	Nov. 9, 1900	6,000	6,000	None.
Taylor	20	Mar. 24, 1888	1,000	1,400	None.
Below Naches River and above Atanum Creek.					
Moxee [b] Hubbard	150	Oct. 11, 1892	3,500	4,500	None.
Fowler	160	July 13, 1892	2,000	3,000	None.
Granger					
Below Atanum Creek.					
New reservation No. 2	1,000	Feb. 19, 1903	2,700	23,700	[j] 53,000
Old reservation No. 1	None.		8,000	17,000	None.
Government canal No. 3	None.			2,300	None.
Sunnyside [b]	1,000	Mar. 23, 1891	35,000	66,000	[j] 156,000
Gilbert	None.		3,000	4,000	None.
Hatch			600		None.
Prosser Falls [c]	(k)		1,200	2,200	None.
Ledbetter	1,000	July 22, 1892		360	None.
Kiona [d]	1,000	Aug. 28, 1889	1,800	800	[j] 26,000
Kiona Water Supply Co			150	150	None.
Kennewick [b]	300	Aug. 6, 1891	6,000	14,000	None.
Grosscup's	(l)	do		3,000	None.
Total			79,150	165,110	235,000

[a] Already constructed. Length as proposed, 65 miles.
[b] Contract, 1 second-foot per 160 acres.
[c] Power canal. Contract, old, 1 second-foot per 160 acres; new, 1 second-foot per 120 acres.
[d] Contract, 1 second-foot per 100 acres.
[e] "Acres irrigated" included in "Acres irrigable."
[f] From Lake Kachess.
[g] Yakima River.
[h] Miner's inches.
[i] Began using water.
[j] Additional.
[k] All river at this point.
[l] Uses same appropriation as Kennewick.

Canals taking water from Yakima River—Continued.

Canal.	Discharge in second-feet.								Total.
	Apr. 16–30.	May.	June.	July.	Aug.	Sept.	Oct. 1–15.	Average.	
Below Cleallum River and above Naches River.									
Cascade								[a]125	
West Kittitas	50	50	53	48.8	52.2	55	56	52	
Town	100	110	122	124	127	116		116	
Olsen								14	
Selah-Moxee	98	77.8	76.9	69.5	78.2	72.6	39	74.9	
Taylor								11	393
Below Naches River and above Atanum Creek.									
Moxee [b]	17	18	18.3	10.3	35.4	30.7	4	21.1	
Hubbard	18	31	24.1	23.5	37.4	18.9	15	24.8	
Fowler	25	34	22	23.6	23	33	16	25.9	
Granger								18	90
Below Atanum Creek.									
New reservation	20	27	49.1	86.4	69	73.6	50	56.4	
Old reservation	100	130	145	164	147	100	90	130	
Government canal No. 3								10	
Sunnyside [b]	496	529	561	585	610	524	456	547	
Gilbert	25	40	58.9	47.9	28.6	17	10	35.1	
Hatch								8	
Prosser Falls [c]	190	210	214	212	201	195	209	205	
Ledbetter								2	
Kiona [d]	17	20	20	21.1	19	20.3	21.3	19.9	
Kiona Water Supply Co								19	
Kennewick [b]	53.6	85.5	101	117	126	126	124	107	
Grosscup's									1,130
Total									1,622

Canals taking water from Tieton and Naches rivers.

Canal.	Location.					Length in miles.
	Nearest town.	Head works.			Bank of river.	
		Section.	Township.	Range.		
From Tieton River.						
Sinclair and Cobb	North Yakima	10	14 N	16 E	Left	
From Naches above Tieton River.						
Selah Valley [e]	North Yakima	35	15 N	16 E	Left	20
Small ditches (combined)						
From Naches below Tieton and above Cowiche Creek.						
Wapatox	North Yakima	36	15 N	16 E	Left	16
Cox	do	6	14 N	17 E	Right	
Upper Scott	do	4	14 N	17 E	do	
Lower Scott	do	9	14 N	17 E	do	
Fortune	do	9	14 N	17 E	do	

[a] Estimated capacity of canal.
[b] Contract, 1 second-foot per 160 acres.
[c] Power canal. Contract, old, 1 second-foot per 160 acres; new, 1 second-foot per 120 acres.
[d] Contract, 1 second-foot per 100 acres.
[e] Contract: Old, 1 second-foot to 160 acres; new, 1 second-foot to 100 acres.

Canals taking water from Tieton and Naches rivers—Continued.

Canal.	Location.					Length in miles.
	Nearest town.	Head works.			Band of river.	
		Section.	Township.	Range.		
From Naches below Tieton and above Cowiche Creek—Continued.						
Laswell	North Yakima	14	14 N.	17 E.	Right	
Yakima Valley	do	24	14 N.	17 E.	do	22
Rhodenbach-Schuler	do	6	13 N.	18 E.	do	
Clark	do		14 N.	17 E.	Left	
Lowry	do		14 N.	17 E.	do	
Kelly	do		14 N.	17 E.	do	
Gleed	do	24	14 N.	17 E.	do	6
Morrisey	do	25	14 N.	17 E.	do	
White and Leach	do	(a)			do	
McCormick	do	(a)			do	
Shearer-Chapman	do	(b)			do	
Naches-Cowiche	do	9	13 N.	18 E.	Right	7
From Naches below Cowiche Creek.						
Broadgauge [c]	North Yakima	10	13 N.	18 E.	Right	3
Power [c]	do	10	13 N.	18 E.	do	6
Shanno [c]	do	11	13 N.	18 E.	do	8
Union	do	11	13 N.	18 E.	do	8½
Town	do	12	13 N.	18 E.	do	

Canal.	Appropriation.		Area under canal—		Proposed extension.
	Amount in second-feet.	Date.	Irrigated.	Irrigable.	
From Tieton River.			*Acres.*	*Acres.*	*Acres.*
Sinclair and Cobb			320	320	None.
From Naches above Tieton River.					
Selah Valley	800	Nov. 13, 1888	6,000	9,500	[d] [e] 5,000
Small ditches (combined)					None.
From Naches below Tieton and above Cowiche Creek.					
Wapatox	30	Apr. 13, 1888	1,400	2,000	[d] 3,000
Cox			60	210	None.
Upper Scott			200	600	None.
Lower Scott			150	400	None.
Fortune	1,000	Apr. 23, 1892	200	400	None.
Laswell	[f] 5,000		275	650	None.
Yakima Valley	150	Mar. 12, 1894	3,600	4,200	None.
Rhodenbach-Schuler	5	1882-1892	300	300	None.
Clark	[f] 1,500	Mar. 6, 1889	400	450	None.
Lowry	[f] 2,000	—— —, 1884	300	400	None.
Kelly			500	600	None.
Gleed	100	Apr. 1, 1889	1,400	1,400	None.
Morrisey	[f] 300	Nov. 13, 1894	300	400	None.
White and Leach			200	300	None.
McCormick			200	200	None.
Shearer-Chapman			400	400	None.
Naches-Cowiche	100	Feb. 9, 1895	1,500	1,500	None.

[a] About 2 miles below Gleed canal.
[b] About 4 miles below Gleed canal.
[c] Property of the Northwestern Light and Power Company.
[d] Additional.
[e] Pipe line extensions.
[f] Miner's inches.

Canals taking water from Tieton and Naches rivers—Continued.

Canal.	Appropriation.		Area under canal—		Proposed extension.
	Amount in second-feet.	Date.	Irrigated.	Irrigable.	
From Naches below Cowiche Creek.			*Acres.*	*Acres.*	*Acres.*
Broadgauge	16	—— —, 1885	500	800	None.
Power	450 400	Oct. 1, 1889 Jan. 8, 1902	250	250	None.
Shanno	60	—— —, 1870	1,000	1,600	None.
Union	(a)	None.[b]	2,000	3,000	None.
Town			640	640	
Total			22,090	30,520	

Canal.	Discharge in second-feet.								
	Apr. 16–30.	May.	June.	July.	Aug.	Sept.	Oct. 1–15.	Average.	Total.
From Tieton River.									
Sinclair and Cobb								5	5
From Naches above Tieton River.									
Selah Valley	45	59	83.3	69.5	86.7	80.8	60.0	72.0	
Small ditches (combined)								15	87
From Naches below Tieton and above Cowiche Creek.									
Wapatox	20.0	40.0	37.2	29.0	37.0	26.1	14.8	31.2	
Cox								4	
Upper Scott								7	
Lower Scott								10	
Fortune								7	
Laswell								10	
Yakima Valley	40.0	46.8	55.3	62.5	77.5	60.8	43.4	57.4	
Rhodenbach-Schuler								6	
Clark								5	
Lowry								15	
Kelly								[c] 30	
Gleed	40	65	61.1	55.9	69.4	38.8	28.0	54.2	
Morrisey								[c] 6	
White and Leach								[c] 8	
McCormick								[c] 5	
Shearer-Chapman								6	
Naches-Cowiche	30.0	42.0	38.9	38.9	53.5	29.1	24.0	38.4	300
From Naches below Cowiche Creek.									
Broadgauge	4.0	5.5	[d] 17.0	[d] 15.9	[d] 16.3	[d] 10.0	[d] 8.0	[d] 11.8	
Power	170	174	178	176	189	199	196	183	
Shanno	20.0	21	29.1	[d] 30	[d] 30	[d] 19	[d] 15	[d] 24.4	
Union	35	41.7	39	37.3	36.9	32.0	30.0	36.6	
Town	10	14	12.3	12.5	14.5	11.4	10.0	12.5	[e] 268
Total									[e] 660

[a] Agrees to deliver 3,000 inches.
[b] First used water, 1869.
[c] Partly seepage water from canals above.
[d] From Power canal.
[e] Forty second-feet estimated amount included in discharge of other canals drawing from Power canal.

SNAKE RIVER (NORTH FORK) NEAR ORA, IDAHO.

This station was established August 20, 1902, by N. S. Dils, and a temporary gage was set. It is located at the North Fork Bridge, 2 miles south of Ora and 10 miles above St. Anthony, Idaho. A permanent vertical gage was set on October 6, 1904, by William G. Davies. The zero of this permanent gage is at the same elevation as the zero of the temporary gage. This gage consists of a 2 by 12 inch plank securely spiked to the first bridge pier from north abutment. This plank is beveled on one edge. The gage is graduated to feet and half tenths painted white, and marked with United States Geological Survey name plate. The observer is Mrs. Martha J. Fritz. The initial point for soundings is a bolt through the toe of the end brace on the lower side of the north end of the bridge. The bridge is 210 feet long. It consists of four spans resting on three rock-filled crib piers. Measurements are made from the lower side of this bridge. The channel is straight both above and below this station. The banks are high and do not overflow. The bed of the stream is hard gravel, quite smooth, and not liable to change. The current is swift. Bench mark No. 1 is a United States Geological Survey aluminum tablet set in a large rock about 30 feet northeast from north end of bridge. Its elevation is 12.84 above zero of gage. Bench mark No. 2 is a cross on a large flat rock marked "B. M." 25 feet northeast from north end of bridge. Its elevation is 11.10 feet above zero of gage.

The observations at this station during 1904 have been made under the direction of D. W. Ross, district engineer.

Discharge measurements of Snake River (Nork Fork) near Ora, Idaho, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
April 12	F. S. Stockton	177	361	3.31	2.1	1,194
May 3	do	177	593	5.37	3.3	3,183
May 17	Wm. G Davies	178	717	6.45	4.1	4,623
July 11	do	177	423	3.60	2.4	1,523

Mean daily gage height, in feet, of Snake River (North Fork) near Ora, Idaho, for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.0	2.0	2.0	1.9	3.0	3.3	2.5	2.3	2.2	2.2	2.2	2.1
2	2.0	2.0	2.0	1.9	3.3	3.3	2.5	2.3	2.2	2.2	2.2	2.1
3	2.0	2.0	2.0	1.9	3.3	3.5	2.5	2.3	2.2	2.2	2.2	2.1
4	2.0	2.0	2.0	2.0	3.7	3.3	2.5	2.2	2.2	2.2	2.2	2.1
5	2.0	2.0	2.0	2.0	3.8	3.2	2.5	2.2	2.2	2.2	2.2	2.1
6	2.0	2.0	2.0	2.0	4.2	3.2	2.6	2.2	2.2	2.2	2.2	2.1
7	2.0	2.0	2.0	2.0	4.1	3.1	2.6	2.2	2.2	2.2	2.2	2.1
8	2.0	2.0	2.0	2.0	4.0	3.1	2.4	2.2	2.2	2.2	2.2	2.1
9	2.0	2.0	2.0	2.0	4.1	3.1	2.4	2.2	2.2	2.2	2.2	2.1
10	2.0	2.0	2.0	2.0	4.2	3.1	2.4	2.2	2.2	2.2	2.2	2.1
11	2.0	2.0	2.0	2.0	4.0	3.0	2.4	2.2	2.2	2.2	2.2	2.1
12	2.0	2.0	2.0	2.1	4.0	3.0	2.4	2.2	2.2	2.2	2.2	2.1
13	2.0	2.0	2.0	2.2	4.0	3.0	2.4	2.2	2.2	2.2	2.2	2.1
14	2.0	2.0	2.0	2.3	4.1	3.0	2.4	2.2	2.2	2.2	2.2	2.1
15	2.0	2.0	2.0	2.4	4.2	2.9	2.4	2.2	2.2	2.2	2.2	2.1
16	2.0	2.0	2.0	2.4	4.1	2.9	2.4	2.2	2.2	2.3	2.2	2.1
17	2.0	2.0	1.9	2.3	4.1	2.8	2.3	2.2	2.2	2.3	2.2	2.1
18	2.0	2.0	1.9	2.3	4.1	2.8	2.3	2.1	2.2	2.3	2.2	2.1
19	2.0	2.0	1.9	2.4	4.2	2.8	2.3	2.1	2.2	2.2	2.2	2.1
20	2.0	2.0	1.9	2.5	4.5	2.8	2.3	2.1	2.2	2.2	2.2	2.1
21	2.0	2.0	1.9	2.5	4.3	2.7	2.3	2.1	2.2	2.2	2.1	2.1
22	2.0	2.0	1.9	2.4	4.2	2.7	2.3	2.1	2.2	2.2	2.1	2.1
23	2.0	2.0	1.9	2.3	4.2	2.7	2.3	2.1	2.2	2.2	2.1	2.1
24	2.0	2.0	2.0	2.3	4.0	2.6	2.3	2.2	2.2	2.2	2.1	2.1
25	2.0	2.0	2.0	2.3	3.8	2.6	2.3	2.2	2.2	2.2	2.1	2.1
26	2.0	2.0	2.0	2.4	3.5	2.6	2.3	2.2	2.2	2.2	2.1	2.1
27	2.0	2.0	1.9	2.5	3.4	2.6	2.3	2.2	2.2	2.2	2.1	2.1
28	2.0	2.0	1.9	3.0	3.3	2.6	2.3	2.2	2.2	2.2	2.1	2.1
29	2.0	2.0	1.9	2.9	3.2	2.5	2.3	2.2	2.2	2.2	2.1	2.1
30	2.0	.....	1.9	2.9	3.3	2.5	2.3	2.2	2.2	2.2	2.1	2.1
31	2.0	.....	1.9	.....	3.3	.....	2.3	2.2	.....	2.2	.....	2.2

Rating table for Snake River (North Fork) near Ora, Idaho, from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.90	1,020	2.60	1,900	3.30	3,160	4.00	4,420
2.00	1,110	2.70	2,080	3.40	3,340	4.10	4,610
2.10	1,205	2.80	2,260	3.50	3,520	4.20	4,800
2.20	1,310	2.90	2,440	3.60	3,700	4.30	4,990
2.30	1,425	3.00	2,620	3.70	3,880	4.40	5,180
2.40	1,555	3.10	2,800	3.80	4,060	4.50	5,370
2.50	1,720	3.20	2,980	3.90	4,240		

The above table is applicable only for open-channel conditions. It is based upon 11 discharge measurements made during 1902 to 1904, inclusive. It is well defined between gage heights 2.00 feet and 4.10 feet. The table has been extended beyond these limits.

Estimated monthly discharge of Snake River (North Fork) near Ora, Idaho, for 1904.

[Drainage area, 1,040 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	1,110	1,110	1,110	68,250	1.07	1.23
February	1,110	1,110	1,110	63,850	1.07	1.15
March	1,110	1,020	1,075	66,100	1.03	1.19
April	2,620	1,020	1,448	86,170	1.39	1.55
May	5,370	2,620	4,167	256,200	4.01	4.62
June	3,520	1,720	2,458	146,300	2.36	2.63
July	1,900	1,425	1,541	94,750	1.48	1.71
August	1,425	1,205	1,301	80,000	1.25	1.44
September	1,310	1,310	1,310	77,950	1.26	1.41
October	1,425	1,310	1,321	81,220	1.27	1.46
November	1,310	1,205	1,275	75,870	1.23	1.37
December	1,310	1,205	1,208	74,280	1.16	1.34
The year	5,370	1,020	1,610	1,171,000	1.55	21.10

SNAKE RIVER NEAR MINIDOKA, IDAHO.

Ten miles above the gaging station at Montgomery's ferry occurs a natural dam site, from which, as a starting point, surveys for canal lines have been run, covering the large extent of rolling country susceptible of irrigation on both sides of the river. Measurements at Montgomery's ferry show the amount of water available for irrigation purposes there, and for the newly constructed Twin Falls canals heading 23 miles below, and also the conditions that will exist for power purposes at Shoshone Falls, about 45 miles below, after the irrigable lands of Snake River Valley shall have been reclaimed.

This station was originally established August 5, 1895, at Montgomery's ferry on the stage road from Minidoka to Albion, Idaho.

When the station was visited on October 14, 1899, a comparison was made of the gage rod with the bench mark, and it was found that the rod had moved to a considerable extent, due to the action of the quicksand on the inclined portion of the rod. The heights as recorded by the observer, as well as the discharge measurements, were corrected. Gage readings were not taken during 1900.

The station was reestablished May 1, 1901, and the gage read morning and evening for the remainder of the year. Part of the inclined gage rod which had been moved by quicksand was corrected August 9, 1901, and all previous gage readings were carefully adjusted to correspond with the present position of the rod.

On October 16, 1903, the gage was carefully checked by means of a level. Different sections of the gage were found to be from 0.1 to 0.3 foot too high. The gage was corrected and the gage heights adjusted to conform with the old gage datum. The lower section of the gage is an inclined 4 by 4 inch timber and reads from zero to 6.8 feet. The upper section is vertical and reads from 6.8 to 13 feet. The gage is read twice each day by George Montgomery, the ferryman. Discharge measurements are made from the ferryboat. A tagged wire has been stretched above the ferry cable. The initial point for soundings is the cable support on the right bank. The channel is straight for 300 feet above and below the station and has a width at the ferry of about 800 feet. Both banks are high, without vegetation, and are not liable to overflow. There is but one channel at all stages. The bench mark, established when the original gage was installed, is a spike in the east post of the tool house on the right bank. The spike is 1.2 feet above the ground, 52 feet west of the gage, and has an elevation of 17.50 feet above the zero of the gage. The letters "B. M." are marked in black paint on the post.

The observations at this station during 1904 have been made under the direction of D. W. Ross, district engineer.

Discharge measurements of Snake River near Minidoka, Idaho, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
April 9	F. Stockton	804	3,709	1.48	2.90	5,494
May 5	do	840	6,816	2.73	6.40	18,590
May 12	Wm. G. Davies	865	7,524	2.70	7.05	20,190
June 10	do	881	9,556	3.43	9.30	29,860
July 7	J. B. Bond	782	6,476	2.51	6.70	16,400
August 2	do	817	4,255	1.51	3.50	6,794
August 13	do	798	3,215	1.37	2.20	4,331
September 22	Wm. G. Davies	800	3,592	1.29	2.68	4,655
October 30	do	810	4,034	1.26	3.21	5,521

Mean daily gage height, in feet, of Snake River near Minidoka, Idaho, for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.0	3.0	3.4	3.1	6.0	10.1	6.8	3.55	2.95	2.8	3.2	3.1
2	5.0	3.1	3.5	3.1	6.1	10.1	6.65	3.45	3.15	2.8	3.2	3.2
3	4.9	2.85	3.55	3.0	6.1	10.1	6.7	3.35	3.3	2.8	3.2	3.2
4	4.85	2.65	3.4	3.0	6.2	10.1	6.75	3.15	3.3	2.8	3.2	3.1
5	4.75	2.6	3.4	3.0	6.4	10.2	6.7	3.05	3.3	2.8	3.2	3.1
6	4.6	2.6	3.3	3.0	6.6	10.05	6.8	2.85	3.15	2.8	3.2	3.0
7	4.45	2.6	3.3	3.0	7.0	9.8	6.65	2.65	3.1	2.8	3.2	3.0
8	4.3	2.6	3.4	3.0	7.1	9.4	6.55	2.55	3.1	2.9	3.2	3.0
9	4.15	2.75	3.55	2.95	7.3	9.3	6.35	2.45	3.1	2.9	3.2	3.0

Mean daily gage height, in feet, of Snake River near Minidoka, Idaho, for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
10	4.0	3.2	3.6	2.9	7.25	9.3	6.2	2.35	3.1	3.0	3.2	3.0
11	3.9	[a]3.9	3.6	2.9	7.15	9.3	6.1	2.25	3.0	3.0	3.2	3.0
12	3.8	[a]4.7	3.7	2.9	7.1	9.1	6.1	2.2	2.9	3.0	3.2	3.1
13	3.7	[a]4.45	3.6	2.9	7.4	9.2	6.0	2.1	2.9	3.0	3.2	3.1
14	3.6	[a]3.8	3.5	3.0	7.6	9.1	5.9	2.1	2.8	3.0	3.2	3.2
15	3.65	3.35	3.4	3.15	7.7	8.9	5.9	2.1	2.8	3.0	3.2	3.2
16	3.8	3.15	3.3	3.35	7.8	8.55	5.8	2.1	2.8	3.0	3.2	3.2
17	3.9	3.0	3.3	3.6	8.0	8.4	5.7	2.1	2.8	3.05	3.1	3.2
18	4.0	2.9	3.3	4.0	8.1	8.65	5.55	2.1	2.8	3.1	3.1	3.1
19	4.2	2.75	3.2	4.35	8.3	8.75	5.35	2.1	2.8	3.1	3.1	3.0
20	4.2	2.55	3.2	4.4	8.3	8.8	5.15	2.2	2.8	3.1	3.1	2.9
21	4.05	2.7	3.3	4.5	8.5	8.6	4.95	2.35	2.7	3.1	3.1	2.9
22	3.95	3.45	3.4	4.9	8.9	8.6	4.75	2.3	2.7	3.1	3.1	2.9
23	3.75	3.3	3.4	5.3	9.3	8.6	4.55	2.3	2.7	3.1	3.1	2.9
24	3.65	3.35	3.4	5.3	9.65	8.6	4.35	2.4	2.7	3.1	3.1	2.9
25	3.55	3.25	3.4	5.1	9.9	8.5	4.2	2.45	2.7	3.1	3.1	2.95
26	3.5	3.15	3.3	4.95	10.2	8.4	4.15	2.5	2.7	3.1	3.1	[a]3.45
27	3.4	3.1	3.3	4.75	10.6	8.2	4.05	2.5	2.7	3.2	3.2	[a]3.85
28	3.3	3.2	3.25	4.8	11.0	7.65	3.95	2.6	2.7	3.2	3.2	[a]4.25
29	3.2	3.3	3.2	5.05	10.8	7.25	3.85	2.7	2.8	3.2	3.2	[a]4.6
30	3.1	.....	3.2	5.55	10.45	7.05	3.7	2.7	2.8	3.2	3.2	[a]4.85
31	3.1	.....	3.15	.....	10.2	.....	3.65	2.75	.....	3.2	.....	[a]4.7

[a] Ice.

Rating table for Snake River near Minidoka, Idaho, from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.00	3,930	3.50	6,790	5.00	10,720	7.00	19,000
2.10	4,100	3.60	7,010	5.10	11,060	7.20	19,920
2.20	4,275	3.70	7,240	5.20	11,410	7.40	20,840
2.30	4,450	3.80	7,470	5.30	11,780	7.60	21,760
2.40	4,630	3.90	7,710	5.40	12,160	7.80	22,680
2.50	4,810	4.00	7,950	5.50	12,560	8.00	23,600
2.60	4,995	4.10	8,190	5.60	12,960	8.20	24,560
2.70	5,180	4.20	8,440	5.70	13,360	8.40	25,520
2.80	5,370	4.30	8,690	5.80	13,760	8.60	26,480
2.90	5,560	4.40	8,950	5.90	14,180	8.80	27,440
3.00	5,750	4.50	9,220	6.00	14,600	9.00	28,400
3.10	5,950	4.60	9,490	6.20	15,460	9.50	30,800
3.20	6,150	4.70	9,770	6.40	16,340	10.00	33,200
3.30	6,360	4.80	10,070	6.60	17,220	10.50	35,600
3.40	6,570	4.90	10,390	6.80	18,100	11.00	38,000

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1895 to 1904, inclusive. It is well defined. Above gage height 8.00 feet the rating curve is a tangent, the difference being 480 per tenth.

Estimated monthly discharge of Snake River near Minidoka, Idaho, for 1904.

[Drainage area, 22,600 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January [a]			6,050	372,000	0.338	0.390
February			5,783	332,600	.323	.348
March	7,240	6,050	6,534	401,800	.365	.421
April	12,760	5,560	7,790	463,500	.435	.485
May	38,000	14,600	24,520	1,508,000	1.37	1.58
June	34,160	19,230	28,200	1,678,000	1.58	1.76
July	18,100	7,125	12,970	797,500	.725	.836
August	6,900	4,100	4,881	300,100	.273	.315
September	6,360	5,180	5,576	331,800	.311	.347
October	6,150	5,370	5,778	355,300	.323	.372
November	6,150	5,950	6,083	362,000	.340	.379
December			5,832	358,600	.326	.376
The year			10,000	7,261,000	.559	7.61

[a] Discharge estimated January 1-31-February 11-14-December 26-31 on account of ice gorging.

FALL RIVER AT FREMONT, IDAHO.

This station supersedes the station at Wilson's Mill, near Marysville, which was discontinued December 31, 1903, because of the difficulty of securing an observer. It was established January 1, 1904, when a temporary gage was placed at Fremont, 3 miles below Wilson's Mill, and readings were made from this gage until October 28, when a cable, car, and permanent gage were installed. The gage consists of a 4 by 4 inch timber graduated to feet and tenths, fastened in a vertical position by anchor bolts and vertical braces. It is painted white and marked with United States Geological Survey name plate. The gage is on the south bank of the stream, about 900 feet from Fremont post-office. The zero of this gage is at the same elevation as the zero of the temporary gage. The observer is Mrs. Eva A. Loomis. P. Wilson has been observer of the Wilson's Mill gage during high water. The initial point for soundings is a tin tag marked "I. P." on the inside face of the cable on the south bank of the stream. The cable is about 500 feet below the gage. The channel is straight above and below the station. Both banks are high, wooded, steep, and are not liable to overflow. There is but one channel at all stages. The bench mark is a standard aluminum tablet set in a rock 20 feet from the gage. Its elevation is 10.36 feet above the zero of the gage.

The Brady canal, capacity about 100 second-feet, heads in the right bank of the river between Wilson's Mill and the Fremont station.

The observations at this station during 1904 have been made under the direction of D. W. Ross, district hydrographer.

Discharge measurements of Fall River at Fremont, Idaho, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 19	W. G. Davies	115	640	6.59	[a] 5.20	4,235
June 28	do	114	451	4.62	[a] 3.55	2,096
August 1	J. G. Bond	112	300	3.51	[a] 2.40	1,140
August 14	W. G. Davies	110	246	3.04	[a] 2.28	[b] 739
October 28	do	140	209	2.37	[c] 2.10	496

[a] Gaged at Wilson's Mill.
[b] Gage at Fremont station 2.25. Discharge of Brady canal 85 second-feet. Discharge at Fremont station 654 second-feet.
[c] Gaged at Fremont.

Mean daily gage height, in feet, of Fall River at Fremont, Idaho, for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.0	1.8	1.9	1.9	.....	3.8	3.2	2.4	2.25	2.15	2.1	2.0
2	2.0	1.8	1.9	1.9	.....	3.8	3.2	.....	2.25	2.1	2.1	2.0
3	2.0	1.8	1.9	1.9	.....	3.8	.....	.....	2.2	2.1	2.1	2.0
4	2.0	1.8	1.9	1.9	.....	3.8	3.2	2.3	2.2	2.15	2.05	2.0
5	2.0	1.8	1.9	1.9	.....	3.7	.....	.....	2.2	2.15	2.05	2.0
6	2.0	1.8	1.9	1.9	.....	.....	3.2	2.3	2.18	2.18	2.05	2.0
7	2.0	1.8	2.0	1.9	.....	3.7	.....	.....	2.18	2.2	2.05	2.0
8	2.0	1.8	2.0	1.9	.....	.....	3.2	2.2	2.18	2.2	2.05	2.0
9	2.0	1.8	2.0	1.9	.....	3.7	.....	.....	2.18	2.2	2.05	2.0
10	2.0	1.8	2.0	1.9	.....	.....	3.1	.....	2.18	2.2	2.05	2.0
11	1.9	1.8	2.0	2.0	.....	3.7	.....	.....	2.18	2.2	2.05	2.05
12	1.9	1.8	1.9	2.1	.....	3.6	3.0	.....	2.18	2.15	2.05	2.05
13	1.9	1.8	1.9	2.25	.....	3.6	.....	.....	2.18	2.15	2.05	2.05
14	1.9	1.8	1.9	2.25	.....	3.6	3.0	2.25	2.18	2.1	2.05	2.05
15	1.9	1.8	1.9	2.5	.....	3.6	.....	2.25	2.18	2.1	2.05	2.05
16	1.9	1.8	1.9	2.35	.....	3.6	3.0	2.25	2.18	2.1	2.05	2.05
17	1.9	1.8	1.9	2.3	.....	3.6	.....	2.28	2.18	2.1	2.05	2.05
18	1.9	1.8	1.9	2.3	.....	3.6	3.0	2.28	2.18	2.1	2.05	2.05
19	1.8	1.8	1.9	2.4	.....	3.6	.....	2.28	2.18	2.1	2.05	2.0
20	1.8	1.8	1.9	2.45	.....	3.6	3.0	2.28	2.18	2.1	2.05	2.0
21	1.8	1.8	1.9	2.4	.....	3.6	.....	2.25	2.18	2.1	2.05	2.0
22	1.8	1.8	1.9	2.35	.....	3.6	2.8	2.25	2.15	2.1	2.05	2.0
23	1.8	1.8	1.9	2.3	.....	3.6	.....	2.25	2.18	2.1	2.0	2.0
24	1.8	1.8	1.9	.....	.....	3.6	2.8	2.28	2.18	2.1	2.0	2.0
25	1.8	1.8	1.9	.....	.....	3.6	.....	2.3	2.15	2.1	2.0	2.0
26	1.8	1.8	1.9	.....	.....	3.6	2.7	2.35	2.15	2.1	2.0	2.0
27	1.8	1.8	1.9	.....	.....	3.6	2.6	2.35	2.15	2.1	2.0	2.0
28	1.8	1.9	1.9	.....	.....	3.6	.....	2.35	2.15	2.1	2.0	2.0
29	1.8	1.9	1.9	.....	.....	3.5	.....	2.3	2.15	2.1	2.0	2.0
30	1.8	.....	1.9	.....	.....	3.5	2.5	2.3	2.15	2.1	2.0	2.0
31	1.8	.....	1.9	.....	.....	.....	.....	2.28	.....	2.1	.....	2.0

NOTE.—Gage heights from June 1 to August 8 are based on gage heights at Wilson Mill gage and also on simultaneous readings. Gage heights from October 16 to 22 are interpolated.

TETON RIVER NEAR ST. ANTHONY, IDAHO.

This station was established April 23, 1903, by N. S. Dils. It is located at the bridge on the stage road from St. Anthony to Victor, Idaho. The gage is a vertical 2 by 12 inch timber 8 feet long, spiked to the upstream side of the right crib abutment. A permanent gage was set October 5, 1904. This gage consists of 2 by 12 inch fir timber set vertical and spiked to the upstream side of the north end abutment. The gage is graduated to half tenths of a foot; the graduations being marked by metallic numerals and staples. The gage is painted white, and marked with a United States Geological Survey name plate. The zero of this gage is same elevation as zero of old gage. It is read once each day by William Ferguson. Discharge measurements are made from the two-span bridge to which the gage is attached. The bridge is supported by crib abutments, constructed of logs, filled with lava rock and by a similar middle pier. The initial point from which soundings are made is a large bolt marked "I. P." in the upstream side of the south end abutment. The channel is straight for a short distance above and below the station. The right bank is high, and will not overflow. The left bank will overflow at extreme flood stages. The current is sluggish. Both banks and bed are composed of hard gravel, and the latter is permanent. Bench mark No. 1 is a United States Geological Survey aluminum tablet set in solid rock about 30 feet northeast of north end of bridge. Its elevation is 13.53 feet above the zero of the gage. Bench mark No. 2 is a cross on a large flat rock 40 feet northeast of the right end of the bridge. It is marked "B. M." and has an elevation of 14.25 feet above the zero of the gage. Bench mark No. 3 is a similar rock 60 feet northwest of the right end of the bridge. It is similarly marked, and has an elevation of 14.41 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of D. W. Ross, district engineer.

Discharge measurements of Teton River near St. Anthony, Idaho, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
April 11	F. Stockton	78	376	2.29	2.30	862
May 3	Stockton and Murphy	78	394	2.78	2.60	1,077
June 22	Wm. G. Davies	78	522	4.95	4.10	2,582
July 25	do	78	384	2.40	2.45	921
October 5	do	65	310	1.65	1.70	512

Mean daily gage height, in feet, of Teton River near St. Anthony, Idaho, for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.00	2.70	.....	.....	2.30	4.10	3.30	2.20	1.90	1.70	1.60	1.50
2	3.10	2.70	.....	.....	2.50	4.10	3.30	2.20	1.90	1.70	1.60	1.50
3	3.00	2.70	.....	.....	2.60	4.10	3.30	2.20	1.90	1.70	1.60	1.50
4	2.90	2.70	.....	.....	2.80	3.80	3.20	2.10	1.90	1.70	1.60	1.50
5	2.90	2.70	.....	.....	3.00	3.50	3.10	2.10	1.80	1.70	1.60	1.60
6	2.90	2.70	.....	.....	3.00	3.40	3.00	2.10	1.80	1.70	1.60	1.65
7	2.90	2.70	.....	.....	2.90	3.40	3.00	2.10	1.80	1.70	1.60	1.80
8	2.90	2.70	.....	.....	2.70	3.40	3.00	2.10	1.80	1.70	1.60	1.80
9	2.90	2.70	.....	.....	2.50	3.50	3.00	2.00	1.80	1.70	1.60	1.80
10	2.80	2.90	.....	.....	2.70	3.80	3.00	2.00	1.80	1.75	1.60	1.80
11	2.80	2.90	.....	2.30	2.80	3.90	2.90	2.00	1.80	1.70	1.60	1.80
12	2.80	3.00	.....	2.30	3.00	3.60	2.90	2.00	1.80	1.80	1.60	1.80
13	2.80	3.00	.....	2.30	3.00	3.60	2.90	2.00	1.70	1.80	1.50	1.80
14	2.70	3.00	.....	2.40	3.10	3.60	3.10	2.00	1.70	1.80	1.50	1.80
15	2.70	3.00	.....	2.60	3.40	3.70	2.90	2.00	1.70	1.80	1.50	1.80
16	2.70	3.10	.....	2.60	3.30	3.90	2.70	2.00	1.70	1.80	1.50	1.80
17	2.70	3.10	.....	2.40	3.40	4.00	2.70	2.00	1.70	1.80	1.50	1.80
18	2.70	3.10	.....	2.20	3.60	4.10	2.60	2.00	1.70	1.75	1.50	1.70
19	2.70	3.10	.....	2.40	4.20	4.20	2.50	2.00	1.70	1.75	1.55	1.60
20	2.70	3.10	.....	2.60	4.40	4.20	2.40	2.00	1.70	1.75	1.55	1.50
21	2.70	3.10	.....	2.40	4.40	4.10	2.50	1.90	1.70	1.70	1.55	1.40
22	2.70	3.00	.....	2.30	4.80	3.90	2.50	1.90	1.70	1.70	1.50	1.40
23	2.70	3.00	.....	2.10	5.20	4.00	2.50	1.90	1.70	1.70	1.50	1.40
24	2.70	3.00	.....	2.10	5.60	3.80	2.50	1.90	1.70	1.70	1.50	1.40
25	2.70	3.00	.....	2.00	5.30	3.50	2.40	1.90	1.70	1.70	1.50	1.70
26	2.70	.....	.....	2.00	4.60	3.20	2.40	1.90	1.70	1.70	1.50	1.80
27	2.70	.....	.....	2.20	4.10	3.00	2.40	1.90	1.70	1.70	1.50	1.90
28	2.70	.....	.....	2.60	4.00	3.00	2.40	1.90	1.70	1.65	1.50	1.90
29	2.70	.....	.....	2.50	4.00	3.10	2.50	1.90	1.70	1.65	1.50	1.90
30	2.70	.....	.....	2.40	4.10	3.10	2.30	2.00	1.70	1.65	1.50	2.00
31	2.70	.....	.....	.....	4.00	.....	2.30	1.90	.....	1.65	.....	2.10

Rating table for Teton River near St. Anthony, Idaho, from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.40	365	2.50	955	3.60	1,915	4.70	3,550
1.50	410	2.60	1,020	3.70	2,035	4.80	3,740
1.60	460	2.70	1,085	3.80	2,160	4.90	3,925
1.70	510	2.80	1,155	3.90	2,295	5.00	4,115
1.80	560	2.90	1,230	4.00	2,435	5.10	4,310
1.90	610	3.00	1,310	4.10	2,580	5.20	4,515
2.00	665	3.10	1,395	4.20	2,730	5.30	4,725
2.10	720	3.20	1,485	4.30	2,885	5.40	4,940
2.20	775	3.30	1,585	4.40	3,045	5.50	5,160
2.30	835	3.40	1,690	4.50	3,215	5.60	5,385
2.40	895	3.50	1,800	4.60	3,385		

Estimated monthly discharge of Teton River near St. Anthony, Idaho, for 1904.

[Drainage area, 960 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January [a]	1,395	1,085	1,147	70,530	1.19	1.37
February 1-25 [a]	1,395	1,085	1,243	61,640	1.29	1.20
April 11-30	1,020	665	858	34,040	.894	.665
May	5,385	835	2,130	131,000	2.22	2.56
June	2,730	1,310	2,058	122,500	2.14	2.39
July	1,585	835	1,147	70,530	1.19	1.37
August	775	610	667	41,010	.695	.801
September	610	510	537	31,950	.559	.624
October	560	485	520	31,970	.542	.625
November	460	410	432	25,710	.450	.502
December	720	365	512	31,480	.533	.614
The period				652,400		

[a] River frozen; discharge probably too large.

SNAKE RIVER (SOUTH FORK) AT MORAN, WYO.

This station was established September 21, 1903, by Fred Stockton. It is located directly back of the post-office at Moran, Wyo., and about three-fourths of a mile below the outlet of Jackson Lake. A permanent gage was set on October 23, 1904. This gage is a 4 by 4 inch timber anchored well by three vertical timbers. This gage is inclined; 1.85 feet along the gage is equivalent to 1 foot vertical. The gage is graduated to half-tenths of a foot marked with metallic numbers and copper staples; painted white and marked with United States Geological Survey name plate. The gage is read once each day by Lizzie Roche. Discharge measurements are made from a car and cable about 150 feet below gage. The initial point for soundings is on the inner face of cable support on north side of river. The channel is slightly curved for about 300 feet above the station. Below the station the channel is straight. At and above the station the current is smooth and has a well-distributed velocity. Below the station the current is broken by small bowlders. Both banks are high and are not liable to overflow. The right bank is wooded and the left bank is composed of gravel and is without trees. The bed of the stream is composed of firm gravel. There is but one channel at all stages. The bench mark is a United States Geological Survey iron bench-mark post set about 30 feet from the gage. The elevation is 10.77 feet above zero of gage.

The observations at this station during 1904 have been made under the direction of D. W. Ross, district engineer.

Discharge measurements of Snake River (South Fork) at Moran, Wyo., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
June 26 [a]	Wm. G. Davies	395	1,609	4.31	6.16	6,932
September 1 [a]	do	205	370	2.97	1.95	1,101
October 22	do	190	487	1.09	1.25	530

[a] Gaged at Sheffields Bridge.

Mean daily gage height, in feet, of Snake River (South Fork) at Moran, Wyo., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.2	1.1	1.2	1.5	1.9	6.65	5.4	3.3	2.0	1.5	1.2	1.0
2	1.2	1.1	1.2	1.5	1.9	6.65	5.3	3.3	2.0	1.5	1.2	1.0
3	1.2	1.1	1.2	1.5	1.9	6.7	5.2	3.2	2.0	1.5	1.2	1.0
4	1.1	1.1	1.2	1.5	1.8	6.65	5.1	3.1	2.0	1.5	1.2	1.0
5	1.1	1.1	1.2	1.5	1.9	6.5	5.0	3.0	2.0	1.5	1.1	1.0
6	1.1	1.1	1.3	1.5	2.0	6.35	4.9	2.9	2.0	1.4	1.1	1.0
7	1.1	1.1	1.3	1.4	2.1	6.1	4.8	2.8	2.0	1.4	1.1	1.0
8	1.1	1.1	1.4	1.4	2.2	6.2	4.7	2.7	2.0	1.4	1.1	1.0
9	1.1	1.1	1.4	1.3	2.3	6.1	4.6	2.7	2.0	1.4	1.1	1.0
10	1.1	1.2	1.4	1.3	2.3	6.2	4.5	2.7	2.0	1.4	1.1	1.0
11	1.1	1.2	1.5	1.3	2.4	6.2	4.4	2.7	2.1	1.4	1.1	1.0
12	1.1	1.2	1.5	1.3	2.6	6.2	4.4	2.6	2.1	1.3	1.1	1.0
13	1.1	1.2	1.5	1.3	2.8	6.3	4.4	2.6	2.0	1.3	1.1	1.0
14	1.1	1.2	1.5	1.4	2.9	6.3	4.4	2.6	2.0	1.3	1.1	1.0
15	1.1	1.2	1.5	1.4	3.0	6.4	4.3	2.5	2.0	1.3	1.1	1.0
16	1.1	1.2	1.5	1.4	3.1	6.4	4.2	2.5	2.0	1.3	1.1	1.0
17	1.1	1.2	1.5	1.4	3.1	6.5	4.1	2.4	2.0	1.3	1.1	1.0
18	1.1	1.2	1.5	1.4	3.3	6.6	4.0	2.4	2.0	1.2	1.1	1.0
19	1.1	1.2	1.5	1.5	3.5	6.6	3.9	2.3	1.9	1.2	1.0	1.0
20	1.1	1.2	1.5	1.5	4.1	6.7	3.8	2.3	1.8	1.2	1.0	1.0
21	1.1	1.2	1.5	1.5	4.5	6.7	3.8	2.3	1.8	1.2	1.0	1.0
22	1.1	1.2	1.5	1.6	4.9	6.7	3.8	2.2	1.8	1.1	1.0	1.0
23	1.1	1.2	1.5	1.6	5.3	6.5	3.7	2.2	1.8	1.2	1.0	1.0
24	1.1	1.2	1.5	1.6	6.0	6.3	3.7	2.2	1.8	1.2	1.0	1.0
25	1.1	1.2	1.5	1.6	6.5	6.1	3.6	2.2	1.7	1.2	1.0	1.0
26	1.1	1.2	1.5	1.6	6.7	5.9	3.6	2.1	1.7	1.2	1.0	1.0
27	1.1	1.2	1.5	1.6	6.6	5.7	3.6	2.1	1.7	1.2	1.0	1.0
28	1.1	1.2	1.5	1.7	6.5	5.6	3.5	2.1	1.6	1.2	1.0	1.0
29	1.1	1.2	1.5	1.8	6.5	5.5	3.4	2.0	1.6	1.2	1.0	1.0
30	1.1	.....	1.5	1.8	6.6	5.4	3.4	2.0	1.5	1.2	1.0	1.0
31	1.1	.....	1.5	.....	6.6	.....	3.3	2.0	.....	1.2	.....	1.0

Rating table for Snake River (South Fork) at Moran, Wyo., from September 21, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.00	390	2.50	1,660	4.00	3,530	5.40	5,650
1.10	440	2.60	1,770	4.10	3,670	5.50	5,810
1.20	500	2.70	1,880	4.20	3,810	5.60	5,980
1.30	570	2.80	1,990	4.30	3,950	5.70	6,150
1.40	640	2.90	2,110	4.40	4,100	5.80	6,320
1.50	720	3.00	2,230	4.50	4,250	5.90	6,490
1.60	800	3.10	2,350	4.60	4,400	6.00	6,660
1.70	880	3.20	2,470	4.70	4,550	6.10	6,840
1.80	970	3.30	2,590	4.80	4,700	6.20	7,020
1.90	1,060	3.40	2,720	4.90	4,850	6.30	7,200
2.00	1,150	3.50	2,850	5.00	5,010	6.40	7,380
2.10	1,250	3.60	2,980	5.10	5,170	6.50	7,560
2.20	1,350	3.70	3,110	5.20	5,330	6.60	7,740
2.30	1,450	3.80	3,250	5.30	5,490	6.70	7,930
2.40	1,550	3.90	3,390				

Estimated monthly discharge of Snake River (South Fork) at Moran, Wyo., for 1903 and 1904.

[Drainage area, 820 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1903.						
October	720	640	674	41,440	0.822	0.948
November	640	570	596	35,460	.727	.838
December	640	500	561	34,500	.684	.789
1904.						
January	500	440	446	27,420	.544	.627
February	500	440	481	27,670	.587	.633
March	720	500	667	41,010	.813	.937
April	970	570	714	42,490	.871	.972
May	7,930	970	3,561	219,000	4.34	5.00
June	7,930	5,650	7,190	427,800	8.77	9.78
July	5,650	2,590	3,869	237,900	4.72	5.44
August	2,590	1,150	1,695	104,200	2.07	2.39
September	1,250	720	1,059	630,20	1.29	1.44
October	720	440	574	35,290	.700	.807
November	500	390	428	25,470	.522	.582
December	390	390	390	23,980	.476	.549
The year	7,930	390	1,756	1,275,000	2.14	29.16

SNAKE RIVER (SOUTH FORK) NEAR LYON, IDAHO.

This station was established April 18, 1903, by N. S. Dils. It is located at the old site of Wedekind's ferry, between Lyon and Swan Valley, at the upper end of Conant Valley. It is about 45 miles from Idaho Falls, Idaho. A new gage was set on October 16, 1904. It is on the north bank one-fourth mile below Carr's ferry and about 1 mile above location of gaging station. The gage consists of a 4 by 4 inch timber well anchored, graduated and marked to half tenths of a foot by metallic numerals and staples. The gage is inclined; 1.55 feet along the gage corresponds to 1 vertical; 2.01 on the new gage corresponds to 1.75 on the old gage. The new gage is painted white, with a United States Geological Survey name plate. This gage is read once a day by O. J. Carr. The same volume of water flows past each gage.

Discharge measurements are now made from a cable and car at the old site of Wedekind's ferry. A tagged wire has been installed at the cable. The initial point for soundings is the pin in the top of a log of the crib cable support on the left bank. The channel is straight above and below the station, and the current is swift. The right bank is high and steep and will not overflow. At very high stages the left bank will overflow for a considerable distance and some water will pass around the station through a slough. The bed of the stream is composed of hard gravel, free from vegetation, and permanent. Bench mark No. 1 is a United States Geological Survey iron bench-mark post set about 6 feet from the new gage. The elevation is 11.15 above zero of gage. Bench mark No. 2 is a United States Geological Survey aluminum tablet set in a rock on the left bank about 100 feet above Carr's ferry landing, and is about 6 feet above high-water mark. Its elevation is 10.44 feet above zero of gage. This bench mark is for use in high water when ferry service is discontinued.

The observations at this station during 1904 have been made under the direction of D. W. Ross, district engineer.

Discharge measurements of Snake River (South Fork) near Lyon, Idaho, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 23	Wm. G. Davies	363	3,459	11.90	8.25	41,160
August 1	do	275	2,140	4.39	3.5	9,407
September 4	J. B. Bond	285	1,664	3.14	2.3	5,213
September 7	Wm. G. Davies	260	1,582	2.84	2.1	4,508
October 17	do	260	1,630	2.13	1.75	3,482

Mean daily gage height, in feet, of Snake River (South Fork) near Lyon, for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.52	1.55	1.60	4.40	8.05	6.15	3.65	2.40	1.90	1.50	1.20
2	.....	1.52	1.58	1.60	4.40	8.10	6.00	3.60	2.40	1.90	1.50	1.20
3	1.65	1.52	1.58	1.60	4.40	7.60	5.90	3.50	2.35	1.85	1.50	1.15
4	1.65	1.52	1.58	1.62	4.85	7.20	5.85	3.40	2.35	1.85	1.45	1.10
5	1.65	1.52	1.58	1.65	4.85	7.40	5.80	3.30	2.30	1.85	1.45	1.00
6	1.62	1.52	1.58	1.65	4.90	7.30	5.65	3.20	.....	1.80	1.43	1.00
7	1.62	1.52	1.58	1.70	4.92	7.30	5.50	3.10	.....	1.80	1.40	1.15
8	1.62	1.52	1.60	1.75	4.65	7.10	5.40	3.00	.....	1.80	1.40	1.20
9	1.62	1.52	1.60	1.75	4.40	7.10	5.30	2.90	.....	1.75	1.40	1.15
10	1.62	1.52	1.60	1.80	4.80	7.50	5.20	2.80	.....	1.95	1.37	1.10
11	1.62	1.52	1.60	1.82	5.00	7.60	5.00	2.85	.....	1.95	1.35	1.15
12	1.60	1.52	1.60	1.92	5.20	7.30	5.00	2.80	2.05	1.95	1.30	1.15
13	1.60	1.55	1.60	2.15	5.35	7.00	4.85	2.75	2.05	1.83	1.30	1.20
14	1.60	1.55	1.60	2.30	5.55	7.10	4.75	2.75	2.05	1.80	1.35	1.20
15	1.60	1.55	1.60	2.50	5.80	7.30	4.65	2.75	2.00	1.75	1.30	1.20
16	1.60	1.55	1.60	2.70	5.80	7.50	4.60	2.80	2.00	1.75	1.35	1.15
17	1.60	1.55	1.62	2.90	5.90	7.60	4.50	2.80	2.00	1.75	1.35	1.15
18	1.60	1.55	1.62	3.25	6.20	7.50	4.45	2.80	1.95	1.70	1.35	1.15
19	1.60	1.55	1.62	3.50	6.70	7.55	4.40	2.75	1.95	1.70	1.35	1.15
20	1.60	1.55	1.75	3.80	7.20	7.60	4.35	2.75	1.95	1.70	1.33	1.15
21	1.60	1.55	1.80	3.50	7.30	7.60	4.35	2.65	1.90	1.65	1.30	1.15
22	1.60	1.55	1.65	3.10	7.65	7.50	4.30	2.60	1.90	1.65	1.30	1.15
23	1.60	1.55	1.65	2.80	8.25	7.40	4.25	2.55	1.95	1.65	1.27	1.10
24	1.55	1.55	1.62	3.00	8.90	7.25	4.20	2.40	1.95	1.60	1.25	1.10
25	1.55	1.55	1.62	3.10	9.05	7.60	4.10	2.45	1.95	1.60	1.25	1.15
26	1.55	1.55	1.62	3.45	8.35	6.40	4.05	2.45	1.90	1.60	1.25	1.05
27	1.55	1.55	1.60	3.95	7.50	6.30	4.00	2.50	1.90	1.60	1.25	0.85
28	1.55	1.55	1.60	4.50	7.50	6.20	4.00	2.60	1.90	1.60	1.25	0.85
29	1.55	1.55	1.60	4.45	7.80	6.00	3.90	2.55	1.90	1.55	1.25	1.15
30	1.55	1.55	1.60	4.45	7.75	6.10	3.80	2.50	1.85	1.55	1.25	1.20
31	1.55	1.55	1.60	.....	7.80	.....	3.70	2.45	.....	1.55	.....	1.20

NOTE.—The above gage heights refer to the old gage.

Rating table for Snake River (South Fork) near Lyon, Idaho, from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.80	1,400	2.30	5,160	3.70	10,200	5.20	16,800
.90	1,590	2.40	5,480	3.80	10,600	5.40	17,760
1.00	1,790	2.50	5,800	3.90	11,020	5.60	18,780
1.10	2,000	2.60	6,120	4.00	11,440	5.80	19,840
1.20	2,220	2.70	6,460	4.10	11,860	6.00	20,980
1.30	2,440	2.80	6,800	4.20	12,280	6.20	22,200
1.40	2,670	2.90	7,140	4.30	12,720	6.40	23,500
1.50	2,910	3.00	7,500	4.40	13,160	6.60	24,950
1.60	3,160	3.10	7,860	4.50	13,600	6.80	26,500
1.70	3,420	3.20	8,240	4.60	14,040	7.00	28,200
1.80	3,690	3.30	8,620	4.70	14,480	7.50	32,900
1.90	3,970	3.40	9,000	4.80	14,940	8.00	38,300
2.00	4,260	3.50	9,400	4.90	15,400	8.50	44,300
2.10	4,560	3.60	9,800	5.00	15,860	9.00	50,800
2.20	4,860						

The above table is applicable only for open-channel conditions. It is based upon 8 discharge measurements made during 1903 and 1904. It is well defined between gage heights 1.70 feet and 3.50 feet. The table has been extended beyond these limits.

Estimated monthly discharge of Snake River (South Fork) near Lyon, Idaho, for 1904.

[Drainage area, 5,480 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	3,290	3,035	3,159	194,200	0.576	0.664
February	3,035	2,960	3,004	172,800	.548	.591
March	3,690	3,035	3,195	196,500	.583	.672
April	13,600	3,160	6,639	395,000	1.21	1.35
May	51,450	13,160	24,820	1,526,000	4.53	5.22
June	39,500	20,980	30,720	1,828,000	5.61	6.26
July	21,890	10,200	14,970	920,500	2.73	3.15
August	10,000	5,480	6,972	428,700	1.27	1.46
September	5,480	3,830	4,451	264,800	.812	.906
October	4,115	3,035	3,534	217,300	.645	.744
November	2,910	2,330	2,546	151,500	.465	.519
December	2,220	1,495	2,057	126,500	.375	.432
The year	51,450	1,495	8,839	6,421,800	1.61	21.97

NOTE.—Discharge interpolated for missing gage heights.

WILLOW CREEK NEAR PROSPECT, IDAHO.

This station was established April 21, 1903, by N. S. Dils. It is located at the ranch of Thomas L. Wails, 3 miles east of Prospect and 17 miles from Idaho Falls, Idaho. The temporary gage is a vertical 2 by 4 inch rod driven into the bed of the creek and fastened at the top to a willow root. It is read twice each day by Thomas L. Wails. There is a bridge below the gage at which discharge measurements may be made. The creek is crooked and the banks are covered with willows. Both banks are high and are not liable to overflow except in case of extreme high water, as in 1904. The bed of the stream is composed of mud. When the water is low in the creek water is discharged into it through a canal one-half mile below the temporary gage. This is a temporary station and was discontinued October 8, 1904.

The observations at this station during 1904 have been made under the direction of D. W. Ross, district engineer.

Discharge measurements of Willow Creek near Prospect, Idaho, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 25	Wm. G. Davies	51	511	2.0	7.15	1,103
July 23	do	51	384	0.20	4.05	[a] 79

[a] Backwater.

Mean daily gage height, in feet, of Willow Creek near Prospect, Idaho, for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	2.20			2.15	7.75	5.95	4.40	3.80	1.90	2.70
2	2.20			1.95	8.15	6.10	4.40	3.80	2.30	2.90
3	2.20			1.90	8.80	5.90	4.30	3.80	3.40	2.90
4	2.20			2.05	8.90	5.90	4.05	3.80	3.40	2.90
5	2.20			2.20	10.10	6.05	4.15	3.70	3.40	2.90
6	2.20			2.25	9.90	6.00	4.10	3.80	3.20	3.00
7	2.15			2.40	9.30	5.90	3.90	3.80	2.80	3.00
8	2.10			2.20	9.10	5.50	3.90	3.70	2.80	(a)
9	2.10			2.20	8.80	5.40	4.50	3.70	2.80	
10	(b)			2.20	8.60	5.35	4.05	3.70	2.80	
11				2.30	9.10	5.35	4.10	3.70	2.90	
12				2.55	9.10	5.50	3.80	3.80	2.90	
13				2.85	8.70	5.40	4.10	3.80	2.90	
14				3.25	8.30	5.40	4.20	3.70	2.90	
15				3.50	8.00	5.50	4.00	3.70	2.90	
16				4.35	8.30	5.40	3.90	3.70	2.90	
17				4.60	8.20	5.40	3.85	3.80	2.90	
18			1.90	4.40	7.95	5.40	3.95	3.80	2.80	
19			2.15	4.50	7.75	5.30	4.00	3.80	2.80	
20			2.35	5.35	7.75	5.20	4.00	3.80	2.90	
21			2.50	5.70	7.80	5.20	4.10	3.80	2.80	

[a] Station discontinued. [b] River frozen from January 10 to March 17, inclusive.

Mean daily gage height, in feet, of Willow Creek near Prospect, Idaho, for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
22	.....	.....	2.40	5.85	7.80	4.90	4.00	3.70	3.00	.....
23	.....	.....	2.40	4.90	7.65	4.80	4.00	3.60	3.00	.....
24	.....	.....	2.30	4.65	7.35	4.90	4.00	3.60	3.00	.....
25	.....	.....	2.10	4.20	7.10	4.70	3.90	3.60	2.25	.....
26	.....	.....	2.00	4.25	6.80	4.80	3.90	3.30	2.10	.....
27	.....	.....	2.00	5.35	6.50	4.90	3.90	3.30	2.10	.....
28	.....	.....	2.00	6.55	6.35	4.50	3.80	3.10	2.10	.....
29	.....	.....	2.10	7.70	6.05	4.40	3.90	3.00	2.20	.....
30	.....	.....	2.20	7.70	6.00	4.40	3.90	2.10	2.40	.....
31	.....	.....	2.20	.....	5.80	.....	3.80	2.00	.....	.....

BLACKFOOT RIVER NEAR PRESTO, IDAHO.

This station was established April 17, 1903, by N. S. Dils, and a temporary gage was set. It is located on the ranch of the observer, James Just, 2 miles west of Presto and about 15 miles from Blackfoot, Idaho. A permanent gage was set October 13, 1904. This gage consists of an inclined 4 by 4 inch timber having 1.36 feet on the gage equivalent to 1 foot vertical. The gage is graduated to half-tenths of a foot, marked with metallic numerals, copper staples, and a United States Geological Survey name plate. Discharge measurements are made from a cable and car located about one-fourth mile below the gage. The initial point for sounding is a tag marked "I. P." fastened to the inner face of the cable support on the west bank. The current is sluggish. The banks are high and wooded and will not overflow. The bed of the stream is gravel, free from vegetation, and permanent. The bench mark is a copper plug set in corner stone of James Just's brick house. The elevation is 12.18 above the zero of the gage.

The observations at this station during 1904 have been made under the direction of D. W. Ross, district engineer.

Discharge measurements of Blackfoot River near Presto, Idaho, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 4	Fred Stockton	60	441	2.70	6.6	[a] 1,193
June 14	Wm. G. Davies	54	208	2.44	2.65	508
July 2	J. B. Bond	54	160	1.26	1.1	220
July 27	do	53	125	1.11	0.7	146
August 30	do	53	161	1.48	1.1	235

[a] Surface velocity taken.

Mean daily gage height, in feet, of Blackfoot River near Presto, Idaho, for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	(a)	.....	.....	1.1	5.7	3.75	1.1	0.7	0.9	1.1	1.4	1.1
2	.....	.....	.....	1.0	5.85	3.95	1.1	.7	.9	1.1	1.35	1.1
3	.....	.....	.....	1.1	5.75	3.85	1.1	.7	.9	1.2	1.3	1.2
4	.....	.....	.....	1.1	6.3	3.8	1.1	.7	.9	1.2	1.3	1.2
5	.....	.....	.....	1.2	6.85	3.6	1.1	.7	.9	1.2	1.3	1.15
6	.....	.....	1.0	1.3	6.65	3.65	1.1	.7	.9	1.2	1.3	1.3
7	.....	.....	1.1	1.3	6.75	3.5	1.1	.7	.9	1.2	1.3	1.2
8	.....	.....	1.4	1.3	7.0	3.5	1.1	.7	.9	1.2	1.3	1.4
9	.....	.....	1.4	1.4	7.05	3.35	1.0	.7	.9	1.2	1.3	1.4
10	.....	.....	1.2	1.4	6.7	3.25	1.0	.7	.9	1.2	1.3	1.2
11	.....	.....	1.1	1.5	6.3	3.2	1.0	.7	.9	1.3	1.3	(a)
12	.....	.....	1.1	1.8	6.25	3.0	.9	.7	.9	1.3	1.25	.....
13	.....	.....	1.2	2.1	6.05	2.9	.9	.7	.9	1.3	1.25	.....
14	.....	.....	1.1	2.65	6.25	2.7	.9	.8	1.0	1.3	1.2	.....
15	.....	.....	1.1	3.15	6.15	2.5	.9	.8	1.0	1.3	1.2	.....
16	.....	.....	1.1	4.2	6.05	2.2	.8	.8	1.0	1.3	1.2	.....
17	.....	.....	1.1	4.4	5.8	2.2	.8	.8	1.0	1.3	1.2	.....
18	.....	.....	1.2	4.65	5.7	2.1	.8	.8	1.0	1.3	1.2	.....
19	.....	.....	1.4	5.5	5.45	2.0	.8	.8	1.0	1.35	1.2	.....
20	.....	.....	1.6	6.75	5.3	1.8	.8	.8	1.1	1.35	1.2	.....
21	.....	.....	1.4	6.9	5.45	1.6	.8	.8	1.1	1.35	1.2	.....
22	.....	.....	1.4	6.1	5.3	1.5	.7	.8	1.1	1.4	1.2	.....
23	.....	.....	1.3	5.65	5.05	1.5	.7	.8	1.1	1.4	1.15	.....
24	.....	.....	1.3	5.2	5.0	1.4	.7	.8	1.1	1.4	1.15	.....
25	.....	.....	1.2	5.05	4.9	1.4	.7	.8	1.1	1.4	1.15	.....
26	.....	.....	1.3	5.1	4.75	1.3	.7	.8	1.1	1.4	1.15	.....
27	.....	.....	1.3	5.55	4.65	1.2	.7	.8	1.1	1.4	1.1	.....
28	.....	.....	1.2	5.7	4.4	1.2	.7	.8	1.1	1.4	1.1	.....
29	.....	.....	1.2	5.6	4.2	1.2	.7	.9	1.1	1.4	1.1	.....
30	.....	.....	1.1	5.4	4.0	1.2	.7	.9	1.1	1.4	1.1	.....
31	.....	.....	1.1	.....	3.85	.....	.7	.9	.....	1.4	.....	.....

[a] River frozen from January 1 to March 5, and December 11 to 31, inclusive.

BIG LOST RIVER NEAR MACKAY, IDAHO.

This station was established November 12, 1903, by Fred Stockton and a temporary gage was set. It is located 3½ miles above Mackay, Idaho, above "The Narrows." A permanent gage was set November 3, 1904, at "The Narrows," about a mile below the temporary gage. It is located back of Joseph Cresto's (the observer) house and consists of a 4 by 4 inch post set vertical and securely anchored, graduated to one-half tenths of a foot, and marked with a United States Geological Survey name plate. Gagings are made from a cableway at the original station site. All gage heights for 1904 were taken from the temporary gage. On November 30, 1904, the temporary gage read 0.90, the permanent gage read 2.80, the discharge being the same at both places.

The channel of the stream is slightly curved both above and below the station. The south bank is steep and high and does not overflow, the north bank slopes gradually and will overflow during high water.

The initial point for soundings is a tin tag marked "I. P." on the inside face of cable support on north bank of stream. A United States Geological Survey iron bench-mark post is set about 15 feet from gage. The elevation is 9.83 above zero of gage.

The observations at this station during 1904 have been made under the direction of D. W. Ross, district engineer.

Discharge measurements of Big Lost River near Mackay, Idaho, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
June 3	Wm. G. Davies	55	222	5.22	3.1	1,162
July 29	J. B. Bond	42	140	3.70	1.7	524
August 18	do	39	112	2.83	1.2	317
September 7	do	38	95	2.48	.9	236
November 3	Wm. G. Davies	36	90	2.05	.95	185

Mean daily gage height, in feet, of Big Lost River near Mackay, Idaho, for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.7	0.65	0.7	0.7	.....	3.8	3.3	1.5	1.0	0.85	0.95	0.85
2	.7	.65	.7	.7	.....	3.9	3.2	1.5	1.0	.85	.95	.85
3	.7	.65	.7	.7	.....	3.7	3.2	1.5	1.0	.85	.95	.85
4	.7	.65	.7	.7	0.5	3.3	3.1	1.4	1.0	.85	.95	.85
5	.7	.65	.7	.7	.55	3.1	3.0	1.4	.9	.85	.95	.85
6	.7	.65	.7	.7	.55	3.0	2.9	1.3	.95	.85	.95	.85
7	.7	.65	.7	.7	.5	3.4	2.8	1.3	.95	.85	.95	.85
8	.7	.65	.7	.7	.55	3.4	2.8	1.3	.95	.85	.95	.85
9	.7	.65	.7	.7	.55	3.4	2.7	1.3	.95	.85	.95	.85
10	.7	.65	.7	.7	.55	3.8	2.8	1.3	.95	.85	.95	.85
11	.7	.65	.7	.7	.5	3.9	2.6	.....	.95	.85	.95	.85
12	.7	.65	.7	.7	.5	3.6	2.6	.....	.95	.95	.95	.85
13	.7	.65	.7	.7	.7	3.4	2.6	.....	.95	.95	.9	.85
14	.7	.65	.7	.7	1.0	3.5	2.6	.....	.95	.95	.9	.85
15	.7	.65	.7	.7	1.3	3.8	2.4	.....	.95	.95	.9	.85
16	.7	.65	.7	.7	1.6	3.9	2.2	1.2	.95	.95	.9	.85
17	.7	.65	.7	.7	1.7	4.2	2.0	1.2	.85	.95	.9	.85
18	.7	.65	.7	.7	2.0	4.4	1.9	1.2	.85	.95	.9	.85
19	.7	.65	.7	.7	2.3	4.4	1.8	1.1	.85	.95	.9	.85
20	.7	.65	.7	.7	2.3	4.4	1.9	1.1	.85	.95	.9	.85
21	.7	.65	.7	.65	2.5	4.1	1.8	1.0	.85	.95	.9	.85
22	.7	.65	.7	.65	2.7	4.0	1.9	1.0	.85	.95	.9	.85
23	.7	.65	.7	.65	3.3	4.0	1.9	1.0	.85	.95	.9	.85
24	.7	.65	.7	.65	3.9	3.9	2.0	1.0	.85	.95	.9	.85
25	.7	.65	.7	.65	4.2	3.5	1.9	1.0	.85	.95	.9	.85
26	.7	.65	.7	.65	4.1	3.2	1.8	1.0	.85	.95	.9	.8
27	.7	.7	.7	.6	3.6	3.0	1.8	1.0	.85	.95	.9	.8
28	.7	.7	.7	.6	3.3	3.0	1.8	1.0	.85	.95	.9	.8
29	.7	.7	.7	.6	3.4	3.1	1.7	1.0	.85	.95	.9	.8
30	.7	.....	.7	.6	3.6	3.2	1.7	1.0	.85	.95	.9	.8
31	.7	.....	.7	.....	3.6	.....	1.6	1.0	.....	.95	.....	.8

Rating table for Big Lost River near Mackay, Idaho, from November 12, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.60	175	1.60	480	2.50	890	3.40	1,300
.70	195	1.70	525	2.60	935	3.50	1,345
.80	215	1.80	570	2.70	980	3.60	1,390
.90	235	1.90	615	2.80	1,025	3.70	1,435
1.00	260	2.00	660	2.90	1,070	3.80	1,480
1.10	285	2.10	710	3.00	1,120	3.90	1,525
1.20	315	2.20	755	3.10	1,165	4.00	1,570
1.30	350	2.30	800	3.20	1,210	4.10	1,620
1.40	390	2.40	845	3.30	1,255	4.20	1,665
1.50	435						

The above table is applicable for open-channel conditions only. It is based upon 5 discharge measurements made during 1904. It is fairly well defined.

Estimated monthly discharge of Big Lost River near Mackay, Idaho, for 1903 and 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
1903.				
December	195	195	195	11,990
1904.				
January	195	195	195	11,990
February	195	185	186	10,700
March	195	195	195	11,990
April	195	175	190	11,310
May [a]	1,665	160	668	41,070
June	1,755	1,120	1,410	83,900
July	1,255	480	813	49,990
August [b]	435	260	318	19,550
September	260	225	238	14,160
October	248	225	240	14,760
November	248	235	240	14,280
December	225	215	223	13,710
The year	1,755	160	410	297,400

[a] Discharge May 1-3 interpolated.

[b] Discharge August 11-15 interpolated.

BIG LOST RIVER NEAR CHILLY, IDAHO.

This station was established April 25, 1904, by Fred Stockton. It is located at Frank Uehren's ranch, about 25 miles upstream from Mackay, 7 miles from Chilly, and about 3 miles above Kinickinick Point. This ranch is the last one on the east bank.

The gage is about one-fourth mile from the ranch house. The gage consists of a 4 by 4 inch timber set vertical, well braced and anchored, and graduated to half tenths of a foot. The graduations are marked by metallic numerals and staples. The gage is painted white and marked with U. S. G. S. name plate. A permanent gage was set November 1, 1904, at the same elevation as the temporary gage. Discharge measurements are made from a cable and car located about three-fourths mile above Uehren's house. The initial point for soundings is a tin tag marked "I. P." on the face of the cable support on east side. The channel is straight for about 200 feet above and 250 feet below the station. Both banks are low and liable to overflow during high water. The stream has but one channel during all stages. A United States Geological Survey iron bench-mark post has been set about 10 feet from the gage. The elevation is 7.49 feet above the zero of the gage. The observer is Frank Uehren.

The observations at this station during 1904 have been made under directions of D. W. Ross, district engineer.

Discharge measurements of Big Lost River near Chilly, Idaho, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
June 4	Wm. G. Davies	80	280	4.39	4.35	1,230
July 29	J. B. Bond	80	195	2.98	3.0	550
August 18	do	80	156	1.85	2.4	309
September 7	do	80	135	1.28	1.8	178
November 1	Wm. G. Davies	80	120	.84	1.57	106

Mean daily gage height, in feet, of Big Lost River near Chilly, Idaho, for 1904.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.1	4.6	4.3	2.8	2.0	1.65	1.6	2.0
2	.....	1.95	4.4	4.2	2.8	1.95	1.6	1.6	2.0
3	.....	1.95	.....	4.3	2.7	2.0	1.6	1.6	2.0
4	.....	2.2	4.3	.....	.....	1.9	1.6	1.55	2.0
5	.....	2.4	4.35	.....	2.7	1.9	1.6	1.6	2.0
6	.....	2.5	4.45	3.8	2.6	1.85	1.6	1.55	2.3
7	.....	2.7	4.25	3.9	2.55	1.85	1.6	1.6	2.3
8	.....	2.7	4.5	3.9	2.55	1.9	1.7	.....	2.3
9	.....	2.9	4.8	3.9	2.5	1.8	1.7	.....	2.2
10	.....	3.1	4.95	3.9	2.5	1.8	1.65	1.6	2.1
11	.....	3.2	4.4	3.7	2.5	1.8	1.6	1.6	2.1
12	.....	3.3	4.15	4.0	2.45	.....	1.6	1.55	2.0
13	.....	3.4	4.3	3.9	2.4	1.8	1.6	1.6	2.0
14	.....	3.8	4.3	3.6	2.45	1.75	.....	1.6	1.9
15	.....	3.9	4.6	3.4	.....	1.7	1.6	1.6	1.7
16	.....	3.9	.....	3.1	2.5	1.7	1.6	1.6	1.6
17	.....	4.05	4.8	3.2	2.4	1.7	1.6	1.5	1.6
18	.....	4.25	4.85	3.05	2.3	1.7	1.65	1.5	1.6
19	.....	4.2	5.1	3.1	2.3	1.7	1.7	1.5	1.5
20	.....	4.1	4.8	3.1	2.2	1.7	1.6	1.5	1.2
21	.....	4.6	4.7	.....	2.1	1.7	1.6	1.5	1.15
22	.....	4.9	4.6	3.2	2.1	1.7	1.6	1.5	1.3
23	.....	5.0	4.35	3.3	.....	1.7	1.6	1.5	1.4
24	.....	4.9	3.9	3.2	2.0	1.7	1.6	1.5	1.5
25	1.7	4.9	4.0	3.2	2.0	.....	1.6	1.5	1.5
26	1.9	4.3	4.1	3.0	2.0	1.7	1.6	1.5	1.3
27	2.15	4.0	4.0	3.1	2.1	1.7	1.6	1.6	1.3
28	2.1	4.2	4.1	3.05	2.0	1.7	1.6	1.6	1.25
29	2.0	4.45	4.6	3.0	2.0	1.7	1.6	1.6	.....
30	2.0	4.5	.....	2.9	2.05	1.65	.....	1.6	.....
31	.....	4.6	.....	2.85	2.05	.....	.....	.....	1.3

Rating table for Big Lost River near Chilly, Idaho, from April 25 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.10	65	2.20	260	3.20	650	4.20	1,155
1.20	80	2.30	285	3.30	700	4.30	1,205
1.30	95	2.40	310	3.40	750	4.40	1,255
1.40	110	2.50	340	3.50	800	4.50	1,305
1.50	125	2.60	370	3.60	850	4.60	1,355
1.60	140	2.70	410	3.70	900	4.70	1,405
1.70	160	2.80	450	3.80	950	4.80	1,455
1.80	180	2.90	500	3.90	1,000	4.90	1,505
1.90	200	3.00	550	4.00	1,050	5.00	1,555
2.00	220	3.10	600	4.10	1,105	5.10	1,605
2.10	240						

The foregoing table is applicable for open-channel conditions only. It is based upon 4 discharge measurements made during 1904. It is well defined between 1.80 feet and 3.00 feet gage height. Above 3.00 feet the table depends on one measurement at 4.35 feet gage height.

Estimated monthly discharge of Big Lost River near Chilly, Idaho, for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April 25–30	250	160	215	2,559
May	1,555	210	898	55,220
June [a]	1,605	1,000	1,284	76,410
July [a]	1,205	475	799	49,130
August [a]	450	220	307	18,880
September [a]	220	150	175	10,410
October [a]	160	140	143	8,793
November [a]	140	125	134	7,974
December [a]	285	73	168	10,330
The period				239,700

[a] Discharge for missing gage heights interpolated.

BIG WOOD RIVER NEAR GIMLET, IDAHO.

This station was established by Fred Stockton on April 25, 1904. It is located on a wagon bridge on the road from Hailey to Ketchum, near Gimlet station on the Oregon Short Line Railroad, a small station about 6 miles from Hailey and 6 miles from Ketchum. The bridge is about 200 feet below the railroad bridge crossing Big Wood River. The gage consists of a 2 by 4 inch timber spiked against a timber on the up-stream side of the north end abutment to the wagon bridge. This gage is graduated to half-tenths of a foot. Graduations are marked by metallic numbers and staples. The gage is marked with a United States Geological Survey name plate. Discharge measurements are made from the bridge. The initial point for soundings is a tin tag marked "I. P." nailed on the hand rail on the downstream side of the bridge. The channel is straight for 250 feet above and 1,000 feet below the bridge. The banks are high and covered with brush and are not liable to overflow, and the stream has but one channel in either high or low water. The bench mark is a United States Geological Survey iron bench-mark post set in the dooryard of the first ranch house above Gimlet. Its elevation above sea level is 5,544 feet and 15.09 feet above zero of gage. The observer is C. A. Comstock.

The observations at this station during 1904 have been under the direction of D. W. Ross, district engineer.

Discharge measurements of Big Wood River near Gimlet, Idaho, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
April 29	Wm. G. Davies	88	214	3.77	1.82	806
May 14	do	88	314	5.71	3.15	1,794
July 8	J. B. Bond	92	239	4.91	2.30	1,293
August 3	do	55	170	3.49	1.25	620
November 10	Wm. G. Davies	37	151	1.25	.75	189

Mean daily gage height, in feet, of Big Wood River near Gimlet, Idaho, for 1904.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		1.7	3.8	2.5	1.2	0.8	0.7	0.7	0.65
2		1.7	3.8	2.7	1.2	.8	.7	.7	.65
3		1 9	3.6	2.6	1.2	.8	.7	.7	.65
4		2.2	3.3	2.4	1.2	.8	.7	.7	.65
5		2.4	3.3	2.3	1.2	.8	.7	.7	.65
6		2.5	3.5	2.2	1.2	.8	.7	.7	.65
7		2.6	3.4	2.2	1.2	.7	.7	.7	.65
8		2.5	3.3	2.3	1.1	.7	.7	.7	.65
9		2.5	3.7	2.3	1.1	.7	.7	.7	.65
10		2 8	3.5	2.2	1.1	.7	.7	.65	.65
11		2.9	3.2	2.1	1.1	.7	.7	65	.65
12		2.9	3.3	2.0	1.0	.7	.7	.65	.65
13		3.0	3.4	1.9	1.0	.7	.7	.65	.65
14		3.2	3.5	1.8	1.0	.7	.7	.65	65
15		3.4	3.6	1.6	1.0	.7	.7	.65	.65
16		3.3	3.7	1.6	1.3	.7	.7	.65	.65
17		3.6	3.9	1.5	1.2	.7	.7	.65	.65
18		3.5	3.9	1.5	1.1	.7	.7	.65	.6
19		3.6	3.8	1.5	1.1	.7	.7	.65	.6
20		3.6	3.6	1.5	1.0	.7	.6	.65	.6
21		4.1	3.7	1.5	1 0	.7	.7	.65	.6
22		4.6	3.5	1.5	1.0	.7	.7	.65	.6
23		4.8	3.3	1.4	1.0	.7	.7	.65	.6
24		5.1	3.0	1.4	1.0	.7	.7	.65	.6
25		5.2	2.9	1.4	.9	.7	.7	.65	.6
26		4.9	2.5	1.4	.9	.7	.7	.65	.6
27		3.8	2.6	1.3	.9	.7	.7	.65	.6
28	1.8	3.8	2.5	1.3	.9	.7	.7	.65	.6
29	1.8	3.8	2.5	1.3	.9	.7	.7	.65	.6
30	1.8	3.9	2.6	1.2	.9	.7	.7	.65	.6
31		3.8		1.2	.9		.7		.6

LITTLE WOOD RIVER NEAR CAREY, IDAHO.

This station was established on April 28, 1904, by William G. Davies. It is located 7 miles upstream from Carey on the Carey-Muldoon road, about one-half mile above dam at head of east and west

side canals, and above the slough or delta section of the river. This station is 35 miles from Picabo, the nearest railroad point. The gage is a 4 by 4 inch timber, set vertical, and bolted to a lava wall. It is graduated to half-tenths of a foot, the graduation being marked by metallic numerals and staples. The gage is painted white and marked with a United States Geological Survey name plate. It is set on the east bank of the river. Discharge measurements are made from a cable and car. The initial point for soundings is a tin tag marked "I. P." on an iron anchor set in a rock on west bank. The channel is straight both above and below the station. The banks are high and clean and not liable to overflow. The stream has one channel at both high and low water and its bed is smooth and clean. The bench mark is a United States Geological Survey aluminum bench-mark tablet set 3 feet from the gage in solid lava. The elevation is 6.00 feet above zero of the gage. Mrs. F. M. Ford is the observer.

The observations at this station during 1904 have been made under the direction of D. W. Ross, district engineer.

Discharge measurements of Little Wood River near Carey, Idaho, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
June 12	Wm. G. Davies	48	128	4.23	2.75	542
July 9	J. B. Bond	46	98	4.49	2.2	457
August 4	do	45	62	2.57	1.4	163
November 9 [a]	Wm. G. Davies	38	79	.85	1.05	67

[a] Gaged above the station.

Mean daily gage height, in feet, of Little Wood River near Carey, Idaho, for 1904.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		4.55	3.4	2.2	1.4	1.0	0.9	1.0	1.0
2		4.8	3.4	2.1	1.4	1.0	.9	1.0	1.0
3		4.1	3.1	2.1	1.4	1.0	.9	1.0	1.0
4		4.15	2.9	2.1	1.4	1.0	.9	1.0	1.0
5		4.5	2.8	2.1	1.4	1.0	.9	1.0	1.0
6		4.15	2.8	2.2	1.4	1.0	1.0	1.0	1.0
7		4.35	3.0	2.2	1.3	1.0	1.0	1.0	1.0
8		4.15	2.9	2.1	1.3	1.0	1.0	1.0	1.0
9		4.35	2.9	2.0	1.3	.9	1.0	1.0	1.0
10		4.4	3.0	2.0	1.3	.9	1.0	1.0	1.0
11		4.6	2.9	1.9	1.2	.9	1.0	1.0	1.0
12		5.0	2.7	2.0	1.2	.9	1.0	1.0	1.0
13		4.75	2.8	2.0	1.2	.9	1.0	1.0	1.0
14		4.95	2.8	2.0	1.2	.9	1.0	1.0	1.0
15		4.05	2.8	2.0	1.2	.9	1.0	1.0	1.0
16		4.25	3.0	2.0	1.2	.9	1.0	1.0	1.0
17		4.15	3.0	1.7	1.3	.9	1.0	1.0	1.0

Mean daily gage height, in feet, of Little Wood River near Carey, Idaho, for 1904—Continued.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
18	.....	4.1	3.0	1.6	1.2	.9	1.0	1.0	1.0
19	.....	4.1	3.0	1.5	1.2	0.9	1.0	1.0	1.0
20	.....	4.75	2.9	1.4	1.2	.9	1.0	1.0	1.0
21	.....	5.05	2.8	1.4	1.2	.9	1.0	1.0	1.0
22	.....	5.1	2.7	1.4	1.1	1.0	1.0	1.0	1.0
23	.....	5.05	2.8	1.5	1.1	.9	1.0	1.0	1.0
24	.....	5.0	2.4	1.4	1.0	.9	1.0	1.0	1.0
25	.....	4.7	2.0	1.4	1.0	.9	1.0	1.0	1.0
26	.....	4.1	2.4	1.3	1.0	.9	1.0	1.0	1.0
27	.....	3.7	2.3	1.3	1.0	1.0	1.0	1.0	1.0
28	4.00	3.6	2.2	1.2	1.0	1.0	1.0	1.0	1.0
29	3.95	3.6	2.2	1.2	1.0	1.0	1.0	1.0	1.0
30	4.10	3.7	2.2	1.2	1.0	1.0	1.0	1.0	1.0
31	.....	3.4	.....	1.3	1.0	.....	1.0	.....	1.0

SUCCOR CREEK NEAR HOMEDALE, IDAHO.

This station was established March 19, 1903, by N. S. Dils. It was discontinued September 30, 1903, but was taken up again before water began flowing in the winter. It is located at a small truss bridge built to carry a flume and is about one-half mile above the mouth of the river. The gage is a vertical rod driven into the bed of the stream, fastened to the downstream side of the footbridge. A new station was established January 31, 1905, about half a mile above the old station and about 17 miles from Caldwell, the nearest railroad station. It is 1 mile west of Homedale, near the Caldwell-Jordan Valley stage road, and 1 mile west of Mussel's ferry on Snake River. This gaging station is one-fourth of a mile below the head of the lowest ditch on Succor Creek, and about three-fourths of a mile above the mouth of the creek. The new gage consists of a 4 by 4 inch post inclined so that 1.27 feet along gage represents 1 foot vertically. This gage is well anchored and bolted, graduated to feet and tenths. The graduations are marked by metallic numbers and staples marked with a United States Geological Survey name plate. The gage is on the left bank of the stream about one-third of a mile above the house of Mrs. Minnie Tracy, the observer. Discharge measurements are made from a cable and car which are located about 10 feet above gage. The initial point for soundings is the inside face of cable support on left bank of stream. The river channel is straight for about 200 feet above and below the station. The bed of stream is gravelly and has one channel at all stages. The right bank is low and slopes uniformly, and may overflow during high water. The left bank is high and not liable to overflow.

A United States Geological Survey iron bench-mark post is set 10 feet back from gage. The elevation is 9.88 feet above the gage zero.

The observations at this station during 1904 have been made under the direction of D. W. Ross, district engineer.

Discharge measurements of Succor Creek near Homedale, Idaho, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
February 19	F. Stockton	30	58	1.35	2.65	78
May 12	do	42	42	1.07	3.40	[a] 45

[a] Backwater.

Mean daily gage height, in feet, of Succor Creek near Homedale, Idaho, for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.6	2.4	2.8	3.25	2.85	2.65						
2	2.6	2.4	2.65	3.4	3.0	2.45						
3	2.6	2.4	2.6	3.35	2.95	2.2						
4	2.6	2.4	2.65	3.25	3.0	2.05						
5	2.6	2.45	2.4	3.2	3.0	1.9						
6	2.6	2.55	2.75	3.3	3.0	2.0						
7	2.6	2.5	4.25	3.4	3.0	2.0						
8	2.6	2.45	4.15	3.4	3.0	2.0						
9	2.6	2.4	4.4	3.2	3.05	1.9						
10	2.6	2.4	4.1	3.25	3.45	1.25						
11	3.45	2.5	4.5	3.55	3.5	1.25						
12	3.0	2.5	3.55	3.5	3.45	1.15						
13	3.05	2.75	3.3	3.5	3.5	1.05						
14	2.65	2.6	3.25	3.5	2.55	1.0						
15	2.6	3.75	3.15	3.45	1.6	1.0						
16	2.65	4.25	3.0	3.45	1.6	([a])						
17	2.65	3.75	2.95	3.2	1.65							
18	2.6	3.45	3.95	3.15	1.65							
19	2.6	3.15	3.35	3.25	1.65							
20	2.5	3.0	3.65	3.95	1.7							
21	2.5	2.75	3.15	3.6	1.65							
22	2.5	5.25	3.05	3.3	1.6							
23	2.5	5.0	2.95	3.1	1.55							
24	2.5	5.15	2.9	3.1	1.65							
25	2.4	4.75	2.8	3.05	1.75							
26	2.4	4.1	2.8	3.0	2.15							
27	2.4	3.55	2.8	2.9	2.25							
28	2.4	3.0	3.25	2.95	2.4							
29	2.4	2.95	5.85	2.9	2.65							
30	2.4		5.1	2.8	2.85							3.5
31	2.4		4.3		2.9							4.0

[a] River dry June 16 to December 29, inclusive.

OWYHEE RIVER NEAR OWYHEE, OREG.

This station was established August 27, 1903, by John H. Lewis. It is located at the county bridge 1½ miles from Owyhee, Oreg. A large irrigation ditch takes water from the river about 6 miles above. The gage is an inclined 2 by 6 inch timber reading from 1 to 5 feet.

It is located at the upstream steel caisson of the left abutment of the bridge. The gage is painted on the vertical caisson from 5 to 18 feet. A standard chain gage was attached to the upstream side of the bridge, near the center of the left span, July 28, 1904. The length of the chain from the end of the weight to the marker is 26.40 feet. It is read once each day by D. T. Rigsby. Discharge measurements are made from the bridge at ordinary stages and by wading above the bridge at extreme low water. The initial point for soundings is the center of the upstream caisson of the left abutment. The channel is straight for 200 feet above and for 400 feet below the station. The current is sluggish at low water. The right bank is high and rocky and will not overflow. The left bank will overflow only at extreme high water. The bed of the stream is composed of sand and gravel, and is liable to shift during freshets. There are two channels at low water and one at high water. The bench mark is the top of the steel caisson, at its outer edge directly above the gage. Its elevation is 18.60 feet above the zero of the gage. The bench mark to which the old station, located at this point, was referred has been destroyed.

The observations at this station during 1904 have been made under the direction of J. T. Whistler, district engineer.

Discharge measurements of Owyhee River near Owyhee, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
March 13 [a]	J. H. Lewis	318	1,606	3.80	7.00	6,195
March 14 [a]	do	318	1,492	3.50	6.60	5,270
April 18	H. D. Newell	300	1,528	3.80	6.70	5,835
May 10 [b]	Murphy and Sawyer	293	888	2.40	4.85	2,156
June 18 [b]	Torkelson and Sawyer	140	330	1.40	3.20	452
July 2 [b]	M. W. Torkelson	133	214	.64	2.45	136
July 28 [c]	Torkelson and Sawyer	55	34	1.00	2.00	34
September 1 [c]	E. N. Smith	47	59	.27	1.90	16
October 12	do	140	219	.76	2.50	168

[a] No water in ditch. [b] Ditch not included. [c] Wading above station.

Mean daily gage height, in feet, of Owyhee River near Owyhee, Oreg., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.00	2.69	6.70	7.90	5.20	4.20	2.40	1.90	1.90	2.05	2.70	2.70
2	2.85	2.64	6.20	6.90	5.10	4.25	2.40	1.85	1.95	2.10	2.65	2.70
3	2.90	2.64	6.00	6.50	5.00	4.20	2.40	1.90	1.90	2.05	2.70	2.75
4	3.00	2.65	5.80	6.40	5.05	4.05	2.40	1.85	1.95	2.10	2.65	2.70
5	3.50	2.68	5.60	6.30	5.10	4.00	2.40	1.80	1.90	2.20	2.70	2.65
6	3.10	2.70	5.60	6.40	5.15	3.95	2.40	1.85	1.95	2.15	2.65	2.60
7	2.90	2.72	6.30	6.45	5.10	3.90	2.45	1.80	1.90	2.20	2.60	2.65

Mean daily gage height, in feet, of Owyhee River near Owyhee, Oreg., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
8	2.75	2.73	6.20	6.20	5.10	3.85	2.40	1.75	1.95	2.30	2.65	3.00
9	2.55	2.75	7.50	6.00	5.00	3.80	2.35	1.70	2.00	2.60	2.70	2.90
10	2.75	2.78	8.20	5.80	4.95	3.75	2.35	1.75	1.95	2.55	2.65	2.85
11	2.90	2.80	8.10	5.70	4.90	3.70	2.35	1.75	2.00	2.60	2.70	2.80
12	3.00	2.81	7.60	5.60	4.95	3.55	2.35	1.70	1.95	2.55	2.65	2.75
13	3.10	2.80	7.20	6.00	4.90	3.50	2.35	1.75	2.00	2.50	2.70	2.70
14	3.05	2.90	7.00	6.30	5.00	3.45	2.25	1.65	2.00	2.55	2.65	2.75
15	2.90	3.00	6.40	6.40	4.90	3.40	2.20	1.70	2.05	2.50	2.70	2.70
16	2.82	6.50	6.20	6.50	4.80	3.35	2.25	1.65	2.00	2.55	2.65	2.70
17	2.75	6.00	6.00	6.70	4.70	3.30	2.15	1.60	2.05	2.50	2.65	2.75
18	2.85	5.60	6.10	6.60	4.60	3.25	2.20	1.60	2.00	2.55	2.70	2.70
19	2.50	6.00	6.40	6.50	4.70	3.10	2.15	1.65	2.05	2.60	2.65	2.75
20	2.40	5.30	7.30	6.40	4.60	3.75	2.20	1.70	2.10	2.70	2.70	2.70
21	2.50	6.00	8.00	6.50	4.55	3.20	2.15	1.65	2.15	2.65	2.65	2.70
22	2.70	6.50	7.80	6.40	4.50	2.90	2.10	1.70	2.10	2.70	2.70	2.75
23	2.80	6.77	7.40	6.30	4.45	2.80	2.10	1.75	2.05	2.65	2.70	2.70
24	2.85	12.20	6.50	6.20	4.40	2.78	2.05	1.70	2.00	2.70	2.65	2.75
25	2.86	9.60	6.40	6.10	4.35	2.70	2.00	1.75	2.05	2.65	2.70	2.70
26	2.88	9.40	6.00	6.00	4.30	2.65	2.05	1.70	2.10	2.70	2.70	2.65
27	2.92	8.60	5.80	5.90	4.35	2.60	2.00	1.75	2.15	2.65	2.70	2.70
28	2.85	8.10	6.20	5.60	4.30	2.55	2.05	1.70	2.10	2.70	2.65	2.75
29	2.80	7.65	7.50	5.40	4.25	2.50	2.00	1.75	2.05	2.65	2.70	2.70
30	2.75	.....	7.90	5.30	4.20	2.45	1.95	1.80	2.10	2.70	2.65	2.75
31	2.70	.....	9.00	.....	4.15	.....	2.00	1.75	.....	2.65	.....	3.00

Rating table for Owyhee River near Owyhee, Oreg., from August 28, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.60	4	3.20	495	4.80	2,070	6.80	5,880
1.70	6	3.30	555	4.90	2,220	7.00	6,360
1.80	9	3.40	620	5.00	2,380	7.20	6,840
1.90	16	3.50	685	5.10	2,540	7.40	7,330
2.00	30	3.60	755	5.20	2,700	7.60	7,840
2.10	50	3.70	830	5.30	2,860	7.80	8,360
2.20	72	3.80	910	5.40	3,020	8.00	8,900
2.30	96	3.90	1,000	5.50	3,190	8.20	9,440
2.40	123	4.00	1,095	5.60	3,370	8.40	9,990
2.50	155	4.10	1,195	5.70	3,550	8.60	10,550
2.60	190	4.20	1,300	5.80	3,740	8.80	11,110
2.70	230	4.30	1,410	5.90	3,930	9.00	11,670
2.80	275	4.40	1,525	6.00	4,130	9.50	13,070
2.90	325	4.50	1,650	6.20	4,540	10.00	14,520
3.00	380	4.60	1,780	6.40	4,970	11.00	17,420
3.10	435	4.70	1,920	6.60	5,420	12.00	20,320

The above table is applicable only for open-channel conditions. It is based upon 12 discharge measurements made during 1903 and 1904. It is well defined between gage heights 1.80 feet and 7.00 feet. The table has been extended beyond these limits.

Estimated monthly discharge of Owyhee River near Owyhee, Oreg., for 1903 and 1904.

[Drainage area, 9,875 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1903.						
September	44	13	27.6	1,642	0.0028	0.0031
October	118	42	97.5	5,995	.0099	.011
November	495	118	338.	20,110	.034	.038
December	408	205	283.	17,400	.029	.033
1904.						
January	685	123	302	18,570	.031	.036
February	20,920	206	3,955	227,500	.401	.432
March	11,670	3,370	6,012	369,700	.609	.702
April	8,630	2,860	4,680	278,500	.474	.529
May	2,700	1,248	1,998	122,900	.202	.233
June	1,355	139	664	39,510	.067	.075
July	139	23	800	4,919	.0081	.0093
August	16	4	7.8	482	.00079	.00091
September	61	16	34.1	2,029	.0035	.0039
October	230	40	162	9,961	.016	.018
November	230	190	219	13,030	.022	.025
December	380	190	250	15,370	.025	.029
The year	20,920	4	1,530	1,102,000	.155	2.09

To obtain the total discharge of the river above the Owyhee ditch division the following monthly discharges of the ditch should be added:

Estimated monthly discharge of Owyhee ditch near Owhee, Oreg., for 1904.

Month.	Total in acre-feet.	Month.	Total in acre-feet.
May	6,926	August	9,104
June	9,726	September	7,571
July	11,054	October 1–20	2,271

BOISE RIVER NEAR BOISE, IDAHO.

The station, established December 15, 1894, is located about 9 miles above Boise, Idaho, at the mouth of the canyon. The original gage was in two sections. The lower part is of 2 by 6 inch plank,

inclined and marked from 1 foot to 7.5 feet; the upper part is a 4 by 4 inch timber, placed vertically, and marked from 7.5 to 12 feet, both portions painted white. The bench mark is a bridge spike driven into a cottonwood tree 20 feet from gage and 20 feet from river. It is 3.40 feet above the 8-foot mark on the gage. Measurements are made from a cable just below the gage.

In the latter part of July, 1895, it was decided to locate a secondary gage on Boise River to obtain the slope of the water surface. This was placed 425 feet below the old gage and carefully connected by means of a level. Both were referred to the same datum. At that time the lower end of the old gage was found to be warped and was corrected. A gage was also placed on the lower Boise in order to determine the water going by at the lowest stage during the irrigating season. The meter can generally be used by wading, but in high water measurements can be made from a wagon bridge.

April 18, 1897, the river cut into the right bank of the station, carrying out the cable and leaving the gage on a small island, so that the record after that date is unreliable. A temporary gage was therefore established May 12 at the Broadway Bridge, at Boise, and a record kept by it until June 17, when a new gage, which is now used, was again placed in the canyon 1 mile above the old location. The inclined rod is firmly attached to a cottonwood tree. The bench mark is a 20-penny spike in the upstream face of the 6 by 8 inch cable support, about 2 feet above the ground. Its elevation is 15.00 feet above datum. Two spikes in same post are 14.00 feet above datum. Discharge measurements are made from a cable and car 50 feet below the gage. An auxiliary cable for flood measurements is placed 117 feet above the main cable. The initial point for soundings is the face of the cable support on the right bank. At ordinary stages the channel is straight, both above and below the station. The banks are high and not liable to overflow. About 300 feet below the cable is a gravel bar, reducing the width of the river at low water to about one-third of the channel and forcing the entire flow against the south bank. The channel is liable to change during extreme high floods. During 1900 the New York Canal Company built a wing dam of timber and loose rock, headed about 150 feet below the station and extending from the north bank diagonally down and across the stream a distance of about 50 feet, in order to protect the north bank from erosion. The construction of this wing dam did not seem to interfere with the flow of the river at the station. During the year 1902 new cable supports were set and bench marks were carefully verified.

The observations at this station during 1904 have been made under the direction of D. W. Ross, district engineer.

Discharge measurements of Boise River near Boise, Idaho, in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 7	F. S. Stockton	300	1,930	6.53	5.95	12,600
June 8	Stockton and Bond	295	1,660	6.08	5.10	10,090
June 28	do	288	1,224	4.44	3.56	5,433
July 16	do	284	796	3.48	2.10	2,772
August 11	do	270	396	2.90	.70	1,188
October 7	do	270	353	2.62	.40	1,003

Mean daily gage height, in feet, of Boise River near Boise, Idaho, for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	0.6	.....	2.5	2.9	5.2	5.7	3.7	1.05	0.3	0.4
2	.....	.....	2.1	2.9	5.2	5.7	3.6	1.0	.05	.35
3	.....	.....	2.1	3.1	5.6	5.3	3.6	1.0	.05	.2
4	.....	0.85	1.95	3.5	6.0	5.0	3.6	1.0	.05	.12
5	.....	.....	1.95	3.7	5.8	5.0	3.2	.95	.05	.2
6	.....	.....	1.95	3.8	5.85	5.2	3.2	1.1	.05	.3
7	.....	.....	2.5	3.7	5.8	5.1	3.2	1.05	−.4	.4
8	.....	.....	4.6	3.75	5.7	5.1	3 2	1.1	−.4	.4
9	.....	.....	5.6	4.1	5 7	5.05	3.2	1.1	−.4	.45
10	.....	.....	4.1	5.3	5.85	5.0	2.9	.65	−.4	.5
11	.....	.....	3.5	5.6	5.85	5.0	2.7	.65	.3	.5
12	.....	.88	3.3	6.25	6.0	4.8	2.5	.6	.3	.5
13	.....	.....	3.1	6.75	6.0	4.6	2.4	.6	.3	.45
14	.....	.....	2.9	7.4	6.1	4.7	2.3	.6	.3	.4
15	.9	.....	2.8	7.85	6.2	4.8	2.2	.58	.3	.4
16	.....	.....	2.6	7.35	6.2	5.2	2.1	.55	.3	.6
17	.....	3.0	2.7	7.0	6.2	5.4	1.9	.58	.3	.6
18	.....	.....	2.8	6.7	6.3	5.3	1.9	.55	.2	.6
19	.....	.....	3.3	7.2	6.3	5.2	1.85	.58	.25	.65
20	.....	.....	3.2	7.4	6.6	4.85	1.8	.55	.2	.5
21	.....	.....	3.05	6.7	7.0	4.7	1.8	.65	.3	.5
22	.....	.....	2.85	5.8	7.4	4.6	1 8	.65	.2	.42
23	.....	.....	2.8	5.2	7.6	4.4	1.85	.65	.3	.4
24	.....	2.5	2.6	4.9	7.4	4.0	1.7	.3	.3	.4
25	.9	.....	2.55	4.9	6.9	3.8	1.6	.3	.3	.4
26	.....	.....	2.4	5.5	6.55	3.6	1.4	.2	.3	.4
27	.....	.....	2.45	6.2	5.8	3.6	1.3	.12	.4	.45
28	.....	.....	2.3	5.7	5.8	3.6	1.3	.12	.4	.4
29	.....	.....	3 2	5.5	6.0	3.7	1.3	.12	.4	.4
30	.....	.....	3.2	5.35	5.6	3.7	1.2	.4	.4	.4
31	.....	.....	2.9	.....	5.7	.....	1.1	.4	.....	.4

Rating table for Boise River near Boise, Idaho, from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
−0.40	280	1.40	1,920	3.20	4,680	5.00	9,440
− .30	350	1.50	2,030	3.30	4,890	5.10	9,770
− .20	425	1.60	2,140	3.40	5,100	5.20	10,110
− .10	500	1.70	2,260	3.50	5,320	5.30	10,450
.00	580	1.80	2,380	3.60	5,540	5.40	10,790
.10	665	1.90	2,500	3.70	5,770	5.60	11,470
.20	750	2.00	2,630	3.80	6,010	5.80	12,150
.30	840	2.10	2,760	3.90	6,250	6.00	12,830
.40	930	2.20	2,900	4.00	6,500	6.20	13,550
.50	1,020	2.30	3,050	4.10	6,760	6.40	14,270
.60	1,115	2.40	3,210	4.20	7,020	6.60	14,990
.70	1,210	2.50	3,370	4.30	7,300	6.80	15,710
.80	1,305	2.60	3,540	4.40	7,580	7.00	16,450
.90	1,400	2.70	3,720	4.50	7,880	7.20	17,210
1.00	1,500	2.80	3,900	4.60	8,180	7.40	17,970
1.10	1,600	2.90	4,090	4.70	8,480	7.60	18,730
1.20	1,705	3.00	4,280	4.80	8,800	7.80	19,490
1.30	1,810	3.10	4,480	4.90	9,120		

The above table is applicable only for open-channel conditions. It is based upon 6 discharge measurements made during 1904. It is fairly well defined between gage heights 0.50 foot and 6.00 feet. The table has been extended beyond these limits.

Estimated monthly discharge of Boise River near Boise, Idaho, for 1904.

[Drainage area, 2,614 square miles.[a]]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
March	11,470	2,565	4,260	261,900	1.63	1.88
April	19,680	4,090	11,200	666,400	4.28	4.78
May	18,730	10,110	13,360	821,500	5.11	5.89
June	11,810	5,540	8,689	517,000	3.32	3.70
July	5,770	1,600	3,257	200,300	1.25	1.44
August	1,600	682	1,156	71,080	.442	.510
September	930	280	730	43,440	.279	.311
October	1,163	682	951	58,480	.364	.420
The period				2,640,000		

[a] Drainage area revised since 1903 report.

MALHEUR RIVER NEAR WESTFALL, OREG.

This station was established December 15, 1903, by John H. Lewis. It is located 3 miles below the Harper ranch, near Westfall, 22 miles above Vale, Oreg. A plain staff gage, graduated to feet and tenths, was attached vertically to a frame bent of a bridge which formerly occupied this site, on the left bank. An inclined gage, graduated to read direct to feet and tenths, was established on the right bank 50 feet above the cable July 27, 1904. The slope is 2 inclined to 1 vertical. The gage is read gratuitously once each day by Lewis Scott, Superintendent Pacific Live Stock Company. Discharge measurements are made by means of a cable, car, tagged wire, and stay wire. The initial point for soundings is the zero of the tagged wire, and is 20.6 feet from the lower end of the turn-buckle. The channel is straight for about 1,000 feet above and 200 feet below the station, and the current is swift. The right bank is low, covered with sage brush, and overflows during high water. The left bank is high, rocky, and not liable to overflow. The bed of the stream is composed of gravel and sand, free from vegetation, and is shifting. There is but one channel at low water, and one main channel and two sloughs at high stages. Bench mark No. 1 is the head of a drift bolt projecting from the top surface at the east end of the frame bent to which the gage is attached. Its elevation is 17.64 feet above the zero of the gage. Bench mark No. 2 is the top of a stake on the left bank near the gage and 75 feet from the river bank. Its elevation is 23.14 feet above the zero of the gage. Bench mark No. 3 is the top of a stake on the right bank, directly in line with the cable and 185 feet from the deadman. Its elevation is 18.50 feet above the zero of the gage.

The bench mark for the inclined gage is a nail in the top of a 3 by 6 inch post to which the stay wire is fastened. Its elevation is 15.92 feet above the zero of the gage. As the inclined gage is referred to a new datum, this bench mark supersedes the others.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurements of Malheur River near Westfall, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
March 8	J. H. Lewis	201	1,330	6.20	11.10	8,300
March 9	do	201	1,456	6.30	11.65	9,150
March 10	do	199	1,009	5.10	9.50	5,160
April 7	Lewis and Newell	198	688	4.31	8.65	2,965
April 13	H. D. Newell	201	896	5.90	9.70	5,290
May 18	J. M. Griffin	195	455	3.77	7.30	1,716
May 25	do	195	439	3.76	7.30	1,652
June 17	Sawyer and Torkelson	190	186	2.40	6.18	446
July 21[a]	M. W. Torkelson	40	58	2.50	5.50	145
August 25[a]	Sawyer and Smith	23	19	2.32	5.25	44
October 23[a]	E. N. Smith	39	46	3.20	5.63	147

[a] Made at different section.

Mean daily gage height, in feet, of Malheur River near Westfall, Oreg., for 1904.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	7.80	8.90	6.60	5.70	5.40	5.20	5.50	5.60
2	.....	8.00	8.60	6.50	5.70	5.40	5.20	5.50	5.60
3	.....	8.20	8.50	6.50	5.70	5.40	5.20	5.50	5.60
4	.....	8.70	8.30	6.40	5.70	5.35	5.20	5.50	5.60
5	.....	8.80	8.30	6.40	5.70	5.35	5.20	5.50	5.60
6	.....	8.60	8.20	6.30	5.70	5.30	5.30	5.50	5.60
7	.....	8.70	8.00	6.30	5.70	5.30	5.20	5.50	5.60
8	11.01	8.30	7.70	6.30	5.70	5.30	5.20	5.55	5.60
9	11.70	8.30	7.80	6.30	5.70	5.30	5.20	5.55	5.60
10	9.40	8.80	7.80	6.30	5.80	5.25	5.20	5.62	5.60
11	8.60	9.10	7.80	6.30	5.80	5.25	5.20	5.60	5.60
12	8.20	9.50	7.80	6.20	5.80	5.25	5.30	5.60	5.60
13	7.80	9.70	7.60	6.20	6.30	5.25	5.30	5.60	5.60
14	7.80	10.20	7.50	6.20	5.70	5.30	5.30	5.62	5.60
15	7.80	10.50	7.50	6.20	5.70	5.30	5.30	5.62	5.60
16	8.30	10.50	7.40	6.20	5.60	5.30	5.30	5.60	5.60
17	8.40	10.20	7.40	6.20	5.60	5.25	5.30	5.60	5.60
18	8.70	10.00	7.30	6.10	5.60	5.25	5.40	5.62	5.70
19	8.70	9.70	7.30	6.10	5.60	5.25	5.40	5.60	5.70
20	8.70	10.70	7.30	6.10	5.60	5.25	5.40	5.60	5.70
21	8.50	10.60	7.30	6.10	5.60	5.25	5.40	5.60	.....
22	8.40	10.60	7.10	6.10	5.50	5.25	5.40	5.60	.....
23	7.30	9.80	7.10	6.00	5.50	5.25	5.40	5.60	.....
24	7.00	9.80	7.20	6.00	5.50	5.25	5.40	5.60	.....
25	6.80	9.50	7.30	5.90	5.50	5.25	5.40	5.60	.....
26	6.70	8.20	7.20	5.80	5.50	5.25	5.55	5.60	.....
27	6.70	9.70	7.10	5.80	5.50	5.30	5.55	5.60	.....
28	6.70	9.20	7.00	5.80	5.50	5.30	5.50	5.60	.....
29	9.10	9.40	6.90	5.80	5.50	5.25	5.50	5.60	.....
30	9.00	9.00	6.80	5.70	5.40	5.25	5.50	5.60	.....
31	8.30	.....	6.70	.....	5.40	5.20	.....	5.60	.....

Rating table for Malheur River near Westfall, Oreg., from March 8 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
5.30	64	6.80	893	8.20	2,513	10.20	6,288
5.40	104	6.90	982	8.30	2,668	10.40	6,696
5.50	146	7.00	1,075	8.40	2,827	10.60	7,104
5.60	188	7.10	1,172	8.50	2,990	10.80	7,512
5.70	230	7.20	1,273	8.60	3,160	11.00	7,920
5.80	274	7.30	1,378	8.70	3,332	11.20	8,328
5.90	318	7.40	1,487	8.80	3,509	11.40	8,736
6.00	362	7.50	1,600	8.90	3,692	11.60	9,144
6.10	411	7.60	1,717	9.00	3,880	11.80	9,552
6.20	463	7.70	1,838	9.20	4,263	12.00	9,960
6.30	519	7.80	1,963	9.40	4,657	12.50	10,980
6.40	581	7.90	2,092	9.60	5,064	13.00	12,000
6.50	650	8.00	2,225	9.80	5,472	14.00	14,040
6.60	727	8.10	2,365	10.00	5,880	15.00	16,080
6.70	808						

The above table is applicable for open-channel conditions only. It is based upon 11 discharge measurements, made during 1904. It is fairly well defined between 5.25 feet and 11.50 feet gage heights.

Estimated monthly discharge of Malheur River near Westfall, Oreg., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January [a]			229	14,080
February [a]			3,099	178,300
March [a]	9,348	808	2,767	170,100
April	7,308	1,963	4,617	274,700
May	3,692	808	1,749	107,500
June	727	230	450	26,780
July	519	104	206	12,670
August	104	34	58	3,566
September	167	34	80	4,760
October	196	146	178	10,940
November [a]			216	12,850
December [a]			230	14,140
The period			1,157	830,400

[a] Estimated January, February, March 1 to 7, November 21 to 30, and December 1 to 31.

MALHEUR RIVER AT VALE, OREG.

This station was established as a temporary station May 20, 1903, by N. S. Dils. The permanent station was established June 30, 1903. It is located at the steel highway bridge one-eighth mile southeast of Vale, Oreg. The lower section of the original gage was an inclined 2 by 6 inch timber under the downstream edge of the bridge, near the left pier. It read from 0 to 14 feet. This section being destroyed by flood February 16, 1904, it was replaced February 25, 1904, by a vertical section nailed to a vertical post 12 feet downstream from caisson at the left abutment of the bridge. The upper section, reading from 14 to 20 feet, was painted on the downstream side of the downstream caisson of the left abutment. A standard chain gage was attached to the downstream side of the bridge near the center of the span July 25, 1904. The length of the chain from the end of the weight to the marker is 30.41 feet.

During 1904 the gage was read twice each day by E. R. Murray and J. A. Newton. Discharge measurements were originally made from the upstream side of the bridge at which the gage is located. On March 2, 1904, a cable, car, and tagged and stay wire were installed about one-fourth mile downstream from the gage and directly opposite the town of Vale. The initial point for soundings is the zero of the tagged wire, on the left bank, 28.7 feet from the lower end of the turn-buckle. The channel is straight for about 200 feet above and 300 feet below the station, and the current is swift. The right bank is high, rocky, free from vegetation, and does not overflow. The left bank is low, composed of firm earth, covered with small sagebrush, and liable to overflow at high water, at which times the water flows in two sloughs on the left bank, which can be measured by wading. The bed of the stream is composed of gravel and sand, free from vegetation, and is liable to shift. There is but one channel at all stages, with the exception of the above-mentioned sloughs. A station has been maintained here at intervals since 1890. The bench mark is the top surface of the east steel caisson at the north end of the bridge. Its elevation is 21.63 feet above the zero of the gage and 2,236.56 feet above sea level.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurements of Malheur River at Vale, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
March 11	J. H. Lewis	156	968	4.85	8.28	4,695
April 5	Lewis and Newell	159	862	4.95	8.42	4,269
April 12	H. D. Newell	162	1,090	5.63	9.33	6,136
April 16	do	.....	1,265	6.26	10.22	7,912
April 24	J. M. Griffin	158	1,050	5.60	8.75	5,670
May 9	Murphy and Sawyer	150	697	3.38	6.82	2,310
June 15	J. M. Griffin	115	312	1.78	5.10	556
June 16	Sawyer and Torkelson	106	290	1.48	4.98	430
July 11	M. W. Torkelson	105	217	1.00	4.40	214
July 20	do	100	185	.60	4.00	107
August 6 [a]	Smith and Torkelson	44	44	1.05	3.75	47
September 24	E. N. Smith	45	46	1.24	3.78	57
October 10 [b]	do	.....	73	1.03	4.08	75

[a] Wading above station. [b] Floats.

Mean daily gage height, in feet, of Malheur River at Vale, Oreg., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.20	4.80	7.00	7.70	8.20	5.65	4.20	3.78	3.75	3.90	4.20	4.35
2	4.00	4.75	7.00	7.40	7.95	5.60	4.20	3.80	3.70	3.90	4.20	4.32
3	4.10	4.50	6.68	8.70	7.80	5.60	4.20	3.80	3.70	3.90	4.20	4.25
4	4.20	4.25	6.45	8.30	7.60	5.60	4.20	3.70	3.70	3.90	4.20	4.10
5	4.20	4.20	6.90	8.55	7.45	5.60	4.20	3.80	3.70	3.92	4.20	4.28
6	4.15	4.20	7.50	8.50	7.35	5.50	4.10	3.75	3.70	3.95	4.25	4.10
7	4.25	4.20	9.10	8.25	7.10	5.50	4.10	3.70	3.70	4.00	4.25	4.20
8	4.35	4.10	10.55	8.08	6.95	5.50	4.70	3.70	3.70	4.40	4.25	4.28
9	4.50	4.00	10.90	8.00	6.80	5.40	4.45	3.70	3.70	4.10	4.25	4.25
10	4.35	4.20	9.50	8.04	6.80	5.40	4.20	3.80	3.70	4.10	4.25	4.20
11	4.30	4.40	8.10	8.07	6.70	5.30	4.30	3.80	3.70	4.10	4.30	4.25
12	4.30	4.55	7.70	9.03	6.70	5.30	4.40	3.80	3.70	4.10	4.25	4.35
13	4.30	4.50	7.10	9.06	6.65	5.20	4.40	3.80	3.70	4.20	4.25	4.35
14	4.30	4.30	6.95	9.08	6.60	5.15	4.35	3.80	3.70	4.20	4.25	4.40
15	4.35	4.45	7.05	10.02	6.50	5.10	4.20	3.80	3.70	4.20	4.25	4.35
16	4.45	10.15	7.15	10.02	6.50	5.00	4.20	3.80	3.70	4.20	4.25	4.10
17	4.60	8.75	6.95	9.90	6.45	4.90	4.20	3.80	3.70	4.20	4.25	4.40
18	4.65	8.55	7.65	9.55	6.40	4.80	4.15	3.80	3.70	4.30	4.30	4.40
19	4.60	7.10	8.05	9.30	6.35	4.80	4.10	3.80	3.70	4.30	4.30	4.40
20	4.50	6.45	8.40	10.10	6.30	4.75	4.00	3.80	3.70	4.20	4.30	4.40
21	4.40	6.00	8.28	10.55	6.20	4.70	4.00	3.80	3.70	4.20	4.30	4.35
22	4.45	13.60	7.20	10.90	6.10	4.70	4.00	3.80	3.75	4.20	4.30	4.20
23	4.55	10.20	7.05	9.70	6.10	4.70	4.00	3.75	3.75	4.25	4.30	4.25
24	4.60	11.10	6.70	9.05	6.15	4.60	4.00	3.75	3.80	4.20	4.35	4.35
25	4.60	13.70	6.38	8.70	6.20	4.60	3.90	3.75	3.85	4.20	4.35	4.20
26	4.80	9.85	6.20	8.45	6.20	4.55	3.95	3.75	3.90	4.20	4.38	4.30
27	4.80	8.15	6.22	8.15	6.05	4.50	3.92	3.75	4.00	4.20	4.40	4.30
28	4.70	7.40	6.40	8.35	6.00	4.40	3.90	3.80	3.95	4.22	4.40	4.40
29	4.65	6.90	7.60	8.50	5.95	4.40	3.88	3.80	3.90	4.20	4.40	4.25
30	4.60	.....	8.45	8.35	5.80	4.30	3.82	3.75	3.90	4.20	4.40	4.25
31	4.75	.....	8.30	.....	5.70	.....	3.82	3.75	.....	4.20	.....	4.75

Rating table for Malheur River at Vale, Oreg., from March 11 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.70	40	5.20	595	6.60	1,921	9.00	5,700
3.80	57	5.30	660	6.70	2,046	9.20	6,076
3.90	81	5.40	729	6.80	2,176	9.40	6,452
4.00	107	5.50	800	6.90	2,311	9.60	6,828
4.10	133	5.60	877	7.00	2,450	9.80	7,204
4.20	159	5.70	958	7.20	2,732	10.00	7,580
4.30	186	5.80	1,044	7.40	3,021	10.50	8,520
4.40	215	5.90	1,138	7.60	3,321	11.00	9,460
4.50	250	6.00	1,240	7.80	3,630	11.50	10,400
4.60	288	6.10	1,345	8.00	3,950	12.00	11,340
4.70	329	6.20	1,454	8.20	4,280	12.50	12,280
4.80	371	6.30	1,566	8.40	4,624	13.00	13,220
4.90	419	6.40	1,681	8.60	4,976	13.50	14,160
5.00	475	6.50	1,800	8.80	5,334	14.00	15,100
5.10	534						

The above table is applicable for open-channel conditions. It is based upon 20 discharge measurements made during 1903 and 1904. It is fairly well defined between gage heights, 3.70 feet and 9.30 feet. The table has been extended above 9.30 feet.

Estimated monthly discharge of Malheur River at Vale, Oreg., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January [a]	371	107	236	14,510
February [a]	14,540	107	3,105	178,600
March [a]	9,272	1,454	3,461	212,800
April	9,272	3,021	5,524	328,700
May	4,280	958	2,027	124,600
June	917	186	533	31,720
July	329	61	146	8,977
August	57	40	52.1	3,203
September	107	40	50.4	2,999
October	215	81	144	8,854
November	215	159	182	10,830
December	350	133	188	11,560
The year	14,540	40	1,304	937,400

[a] January 1 to March 10, inclusive, estimated

MALHEUR RIVER AT M'LAUGHLIN'S BRIDGE, NEAR VALE, OREG.

This station was established December 10, 1904, by W. C. Sawyer. It is located at the new county bridge, known as McLaughlin's bridge, 10 miles above Vale, Oreg. A standard chain gage is attached to the upstream hand rail of the bridge, near the left bank. The length of the chain from the end of the weight to the marker is 21.72 feet. The gage is read weekly during ordinary, and daily during flood stages by R. N. Linebarger. Discharge measurements are made from the iron bridge to which the gage is fastened, consisting of two spans and wooden approaches.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

MALHEUR RIVER AT HALLIDAY'S BRIDGE, NEAR ONTARIO, OREG.

This station was established December 8, 1904, by W. C. Sawyer. It is located at the county bridge, known as Halliday's bridge, which is 10 miles above Ontario, Oreg. A standard chain gage is attached to the upstream handrail of the bridge near the right bank. The length of the chain from the end of the weight to the marker is 23.70 feet. The gage is read daily by T. W. Halliday. The measurements are made from the upstream side of the bridge. The channel is straight for about one-fourth mile above the station and 800 feet below. The right bank is clean, high, and does not overflow. The left bank is clean and high, but overflows at very high water. The bed of the stream is sandy, clean, and shifting. There is one channel at all stages. The initial point for soundings is 20 feet from the truss pin of the upstream truss on the right bank. Bench mark No. 1 is the south end of the bedplate which supports the south end of the upstream truss. Its elevation is 18.99 feet above datum of the gage and 2,201.40 feet above sea level. Bench mark No. 2 is the north end of the bedplate which supports the north end of the upstream truss. Its elevation is 18.89 feet above datum of the gage. A temporary bench mark is the top of the upstream end of the first floor beam from the right bank, 38.5 feet from the initial point for soundings. Its elevation is 19.27 feet above the datum of the gage. This station was established as a temporary one to assure records in case other stations on Malheur River and Willow Creek should be damaged by floods.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurements of Malheur River at Halliday's bridge, near Ontario, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet*
February 23	J. H. Lewis	130	1,073	7.8	12.2	8,370
December 7	W. C. Sawyer	28	48	1.6	2.05	76

Mean daily gage height, in feet, of Malheur River, at Halliday's bridge near Ontario, Oreg., for 1904.

Day.	Dec.	Day.	Dec.	Day.	Dec.	Day.	Dec.
8	2.5	14	2.5	20	2.6	26	2.1
9	2.5	15	2.5	21	2.5	27	2.15
10	2.3	16	2.3	22	2.4	28	2.3
11	2.25	17	2.4	23	2.4	29	2.25
12	2.4	18	2.9	24	2.5	30	2.4
13	2.45	19	2.7	25	2.4	31	3.0

MALHEUR RIVER NEAR ONTARIO, OREG.

This station was established December 8, 1903, by John H. Lewis. It is located at the new county bridge about 2½ miles northwest of Ontario, Oreg., and about 1¼ miles above the junction of the Malheur with Snake River. Brosnan ditch takes water from the river on the left bank 3 miles above the station, and the Nevada ditch, on the right bank 12 miles above. Both conduct some water past the station at certain times. The gage is in two sections. The lower, graduated to read direct to feet and tenths from 2 to 10 feet, is fastened in an inclined position to the left bank just above the bridge. The gage is continued on a vertical staff to 21 feet. The gage was read twice each day by William O'Brien. Discharge measurements were made from the single-span highway bridge. The initial point for soundings is the left end of the upstream railing of the bridge over the pier. Five-foot intervals are marked on the railing with 10-penny nails. The channel is straight for about 150 feet above and 200 feet below the station and the current is sluggish. Both banks are low, covered with brush, and liable to overflow during extreme high water. The bed of the stream is composed of sand and gravel, free from vegetation, and may shift slightly during floods. There is one channel at low, and several at high water, flowing in sloughs which are measured by wading. Floods in Snake River occur at different times from those in Malheur River, but the water surface at the gage is said to have been unaffected by back water during recent years. Bench mark No. 1

is the edge of the steel band on the upstream bridge caisson at the left bank. Its elevation is 18.90 feet above the zero of the gage. Bench mark No. 2 is a notch cut in the southeast corner of the observer's house. Its elevation is 20.00 feet above the zero of the gage. The bridge was washed away in May, 1904, and the station abandoned.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurements of Malheur River near Ontario, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
February 22	J. H. Lewis	110	632	5.00	12.10	3,190
February 22	do	115	790	5.40	13.42	4,270
February 22	do	117	890	5.90	14.35	5,270
February 22	do	117	975	6.30	15.08	6,210

Mean daily gage height, in feet, of Malheur River near Ontario, Oreg., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	Day.	Jan.	Feb.	Mar.	Apr.	May.
1	6.30	6.90	10.60	11.90	13.70	17	8.50	16.60	11.45	15.35	.....
2	6.30	7.00	10.90	12.50	13.45	18	8.50	11.70	12.15	14.80	.....
3	6.30	6.80	10.68	12.35	13.15	19	7.50	9.60	12.45	14.50	.....
4	6.20	6.90	10.28	12.40	13.00	20	7.20	8.55	13.20	15.25	.....
5	6.70	7.28	10.25	13.20	12.85	21	7.20	8.35	13.20	16.45	.....
6	6.60	7.48	10.60	13.75	12.75	22	7.20	11.65	12.05	16.80	.....
7	6.50	6.51	13.00	13.10	12.85	23	7.30	17.40	11.20	15.40	.....
8	6.50	6.52	15.95	13.70	12.55	24	7.30	16.30	10.70	14.70	.....
9	6.50	7.55	16.75	13.10	12.50	25	7.00	17.45	10.15	14.50	.....
10	6.50	6.32	15.45	13.10	12.45	26	6.90	16.60	10.10	13.65	.....
11	6.70	7.38	13.65	13.55	12.42	27	6.80	14.30	10.30	13.65	.....
12	6.80	7.45	12.60	14.15	12.35	28	6.80	13.65	10.35	13.85	.....
13	7.80	7.50	12.10	14.55	12.18	29	6.70	11.10	11.00	13.20	.....
14	7.80	6.92	11.40	14.95	12.20	30	6.90	.....	13.50	12.70	.....
15	7.80	7.38	11.55	15.35	.....	31	6.90	.....	13.15	.....	.....
16	7.80	12.15	11.65	15.55	.....						

BULLY CREEK ABOVE VALE, OREG.

This station was established August 10, 1903, by John H. Lewis. It was located about one-eighth mile below the mouth of Cottonwood Creek and 13 miles from Vale, Oreg. It was about 2 miles below a proposed reservoir site on this creek. The gage was located on the left bank and consisted of 2 by 6 inch timbers. The lower section was inclined and read from 0 to 6 feet. The upper section is vertical and read from 6 to 12 feet. The gage was about 200

feet from the house of F. O'Neill, who read the gage twice each day. Discharge measurements were made by means of a cable and a car about 70 feet below the gage. The initial point for soundings was the zero on the tagged wire on the left bank, 25 feet from the lower end of the turnbuckle. The main channel at ordinary stages is straight for 200 feet above the cable. At flood stages the right bank overflows above the cable, causing a bend in the channel about 75 feet above. The channel is straight for 800 feet below the station. At the cable the right bank is low, will overflow at extreme flood stages, and is covered with sagebrush. The left bank is low, but is not liable to overflow. The bed of the stream is composed of gravel and sand, free from vegetation, and liable to shift. There is but one channel at all stages. Bench mark No. 1 is a projecting stone on the top of the wall in the front of the observer's house on the west side of the entrance. Its elevation is 16.92 feet above the zero of the gage. Bench mark No. 2 is a 2 by 4 inch timber projecting from the northeast corner of the granary, about 42 feet from the gage. Its elevation is 12.37 feet above the zero of the gage.

Owing to changes in the channel and destruction of the original gage by flood the cable was moved 125 feet downstream February 26 and a new gage installed February 27, 1904. The new gage was a 2 by 6 inch timber supported in a horizontal position above high water and projecting over the water. Readings were made by means of a graduated rod by reading down from the bottom of the 2 by 6 inch timber, which was at 11.30 above zero. This gage was at the same datum as the old gage. The water surface between the new and old gage was practically level for gage height 5.50 feet, being 0.03 foot lower at the new gage than at the old.

The station, as reestablished February 27, 1904, was destroyed by flood and abandoned March 11, 1904, a new channel having been formed several hundred feet from the gage. On the latter date a new station was established on Bully Creek near its mouth, at Vale, Oreg. Except for a few days when surface snow is going off no streams enter Bully Creek between the new and the old station. Five small ditches divert water during the irrigation season.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurement of Bully Creek above Vale, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
February 27	J. H. Lewis	82	152	3.60	5.50	560

Mean daily gage height, in feet, of Bully Creek above Vale, Oreg., for 1904.

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1	2.60	2.47	5.00	12	2.60	2.61	.....	22	2.60	7.25	.....
2	2.60	2.42	5.35	13	2.60	2.60	.....	23	2.60	6.75	.....
3	2.60	2.45	5.00	14	2.60	2.54	.....	24	2.60	8.50	.....
4	2.60	2.60	5.24	15	2.60	2.71	.....	25	2.60	7.44	.....
5	2.60	2.60	4.70	16	2.60	6.00	.....	26	2.60	6.20	.....
6	2.60	2.54	5.40	17	2.60	3.90	.....	27	2.57	5.62	.....
7	2.60	2.50	7.80	18	2.60	2.75	.....	28	2.50	5.00	.....
8	2.60	2.50	7.70	19	2.60	2.55	.....	29	2.52	5.10	.....
9	2.60	2.50	5.20	20	2.60	2.50	.....	30	2.51	.....	.....
10	2.60	2.50	5.20	21	2.60	2.50	.....	31	2.50	.....	.....
11	2.60	2.55	.....								

BULLY CREEK AT VALE, OREG.

This station was established April 8, 1904, by John H. Lewis. It is located at the county highway bridge across Bully Creek just above its junction with Malheur River at Vale, Oreg. The station is 13 miles below the former station on this creek, which was destroyed by flood and discontinued March 11, 1904. The original gage consisted of a rod graduated to feet and tenths, by means of which the distance of the water surface below the top of a projecting floor beam on the east side of the bridge was measured. A standard chain gage was attached to the bridge October 29, 1904. The length of the chain from the end of the weight to the marker is 17.22 feet. Discharge measurements are made from the downstream side of the single-span bridge. The initial point for soundings is the south end of the east bridge railing. Five-foot intervals are marked along the bridge with black paint. The channel is straight for about 50 feet above and 300 feet below the station and the current is swift. Both banks are high, clear, and not subject to overflow. The bed of the stream is composed of clay and sand and is shifting. There is but one channel at all stages. Bench mark No. 1 is the top surface of the north projecting floor beam on the east side of the bridge. Its elevation is 15.36 feet above the datum of the gage. Bench mark No. 2 is on the north end of stone doorsill at the north door on the west side of old flour mill about 390 feet southeast of the bridge. Its elevation is 18.80 feet above the datum of the gage. Except for a few days when surface snow is going off no streams enter Bully Creek between this and the old station. Five small ditches divert water during the irrigation season. The station is affected by back water and will not be maintained longer than necessary to make a comparison between the results obtained at this station and the former station 13 miles upstream.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurements of Bully Creek at Vale, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
February 24			268	4.20	7.09	1,120
April 8			181	5.35	7.00	968
April 11			265	5.44	8.40	1,442
April 12			254	5.58	7.50	1,416
April 14	H. D. Newell	50	285	4.90	8.00	1,390
April 16	do	50	269	3.90	7.75	1,050
April 25	J. M. Griffin	45	172	4.06	6.90	698
May 7	do	40	81	2.60	5.76	210
May 9	Murphy and Sawyer	43	79	2.30	5.50	180
June 16 [a]	W. C. Sawyer	14	14	1.60	4.10	22
August 26	Smith and Sawyer	15	5	.75	3.78	4
September 24 [a]	E. N. Smith	9	5	.63	3.75	3

[a] Measurement made at different section.

Mean daily gage height, in feet, of Bully Creek at Vale, Oreg., for 1904.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		6.60	4.10	4.10	3.90	3.70	3.70	3.75	3.65
2		6.40	4.10	4.10	3.90	3.70	3.70	3.75	3.50
3		6.40	4.10	4.10	3.90	3.70	3.70	3.75	3.45
4		6.20	4.10	4.10	3.90	3.70	3.70	3.75	3.20
5		6.30	4.10	4.10	3.90	3.70	3.70	3.70	3.30
6		5.90	4.10	4.10	3.90	3.70	3.70	3.70	3.20
7		5.70	4.10	4.10	3.90	3.70	3.75	3.70	3.45
8	7.00	5.60	4.10	5.00	3.80	3.70	3.75	3.70	3.70
9	7.02	5.50	4.10	4.40	3.80	3.70	3.75	3.70	3.60
10	7.05	5.40	4.10	4.30	3.80	3.70	3.75	3.70	3.70
11	7.50	5.30	4.10	4.20	3.80	3.70	3.75	3.65	3.70
12	8.00	5.10	4.10	4.30	3.80	3.70	3.75	3.65	3.70
13	8.01	5.00	4.10	4.30	3.80	3.70	3.75	3.65	3.80
14	8.02	5.00	4.10	4.30	3.80	3.70	3.75	3.65	3.80
15	8.04	5.00	4.10	4.20	3.80	3.70	3.75	3.65	4.40
16	8.00	5.00	4.10	4.20	3.80	3.70	3.75	3.65	3.70
17	7.08	5.00	4.10	4.20	3.80	3.70	3.75	3.65	3.60
18	7.04	5.00	4.10	4.20	3.80	3.70	3.75	3.65	4.20
19	7.20	4.90	4.10	4.10	3.80	3.70	3.80	3.65	3.60
20	7.80	4.70	4.10	4.10	3.80	3.70	3.80	3.65	3.70
21	7.85	4.50	4.10	4.10	3.80	3.70	3.80	3.65	3.80
22	7.90	4.40	4.10	4.10	3.70	3.70	3.80	3.65	3.70
23	8.00	4.30	4.10	4.10	3.70	3.70	3.80	3.65	3.80
24	7.50	4.20	4.10	4.00	3.70	3.70	3.70	3.65	3.70
25	7.20	4.10	4.10	4.00	3.70	3.70		3.65	3.80
26	7.00	4.10	4.10	4.00	3.70	3.70		3.65	3.80
27	6.80	4.10	4.10	4.00	3.70	3.70		3.65	3.70
28	6.80	4.10	4.10	4.00	3.70	3.70		3.65	3.70
29	6.70	4.10	4.10	4.00	3.70	3.70	3.70	3.65	3.60
30	6.60	4.10	4.10	3.90	3.70	3.70	3.70	3.65	3.60
31		4.10		3.90	3.70		3.75		3.70

Estimated monthly discharge of Bully Creek at Vale, Oreg., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January [a]			12.5	769
February [a]			327	18,810
March [a]			725	44,580
April [a]			1,018	60,580
May	547	22	159	9,777
June	22	22	22.0	1,309
July	112	10.5	26.5	1,629
August	10.5	2.1	5.58	343
September	2.1	2.1	2.10	125
October	5.6	2.1	3.17	195
November	3.3	1.2	1.66	99
December	44	.0	4.34	267
The year			192	138,500

[a] From March 11 to April 7, inclusive, the discharge was estimated.

NOTE.—Owing to the shifting character of the bed the above estimates are only approximate.

WILLOW CREEK NEAR MALHEUR, OREG.

This station was established November 4, 1904, by W. C. Sawyer. It is located at Beer's ranch, about 5 miles from Malheur on the road to Huntington, Oreg. A plain staff gage, graduated to feet and tenths, is attached to an immense bowlder at the mouth of the canyon, about one-half mile below the cable. The gage is read once each day by S. P. Colt. Discharge measurements are made by means of a cable and car. The initial point for soundings is the eyebolt to which the cable is attached at the left bank. The channel is straight for 100 feet above and below the station and the current swift. Both banks are high, clean, and do not overflow. The bed of the stream is composed of rock and gravel, free from vegetation, and is permanent. There is but one channel at all stages. Bench mark No. 1 is a square chisel draft, marked with the letters "B. M." in black paint, on the top of the bowlder to which the gage is fastened, 5.4 feet upstream from the gage. Its elevation is 5.74 feet above the zero of the gage. Bench mark No. 2 is a square chisel draft on top of a rock 14 feet upstream from the cable at a point 21 feet from the anchorage of the right end of the cable. Its elevation is assumed at 100.00 feet for reference for cross section at cable.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurement of Willow Creek near Malheur, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
September 20	W. C. Sawyer	6.5	3.9	1.11	0.7	4.3

Mean daily gage height, in feet, of Willow Creek near Malheur, Oreg., for 1904.

Day.	Nov.	Dec.	Day.	Nov.	Dec.	Day.	Nov.	Dec.
1		0.85	11			21	0.85	0.8
2		.75	12			22	.85	.8
3		.85	13			23	.85	
4			14			24	.85	
5		.95	15			25	.8	
6		.95	16		0.8	26	.85	
7		.95	17		.8	27	.85	
8		.9	18		.8	28	.85	
9		.8	19		.8	29	.85	
10		.8	20	0.85	.8	30	.85	

WILLOW CREEK NEAR DELL, OREG.

This station was established May 12, 1904, by H. D. Newell. It is located at a bridge at Cole's ranch near Dell, Oreg., 28 miles above Vale. A plain staff gage was attached to a pole which was driven into the sand and spiked to the bridge. On November 1, 1904, a standard chain gage was attached, at the same datum, to the downstream side of the bridge. The length of the chain from the end of the weight to the marker is 18.06 feet. The gage is read once each day by Emory Cole. Discharge measurements are made from the downstream side of the wooden highway bridge to which the gage is attached. The bridge has a single span of about 137 feet and trestle approach at each end. The initial point for soundings is the left end of the downstream hand rail. The channel is slightly curved for about 200 feet above and straight for 200 feet below the station, somewhat obstructed by willows. The current is moderate. Both banks are low, but all the water passes between the abutments of the bridge. The bed of the stream is composed of mud and is slightly shifting. There is but one channel at all stages, broken by the bridge bents. Bench mark No. 1 is a group of three spikes driven into a post at the corner of the fence about 40 feet east of the initial point. Its elevation is 14.92 feet above the zero of the gage. Bench mark No. 2 is a cross painted on the top of stone of east abutment 6.5 feet from the initial point and marked "B. M." Its elevation is 14.79 feet above the zero of the gage. Bench mark No. 3 is the top of a bolt at the foot of the inclined end post of the south truss of the bridge, 20 feet from the initial point for soundings. Its elevation is 14.97 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurements of Willow Creek near Dell, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
April 14	H. D. Newell	80	340	2.80	7.06	940
April 15	do	57	328	2.70	6.86	880
April 23	J. M. Griffin	53	175	2.32	5.46	412
May 12	do	52	84	2.23	4.21	187
June 20	Sawyer and Torkelson	35	15	1.20	2.52	18
July 8 [a]	M. W. Torkelson	14	3	1.30	2.29	4
September 3 [a]	E. N. Smith	4	1.5	.99	2.00	1.5
November 1 [b]	W. C. Sawyer	14	8.3	1.34	2.26	11

[a] Floats. [b] Wading.

Mean daily gage height, in feet, of Willow Creek near Dell, Oreg., for 1904.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		5.06	3.30	2.55	1.90	1.90	2.15	2.40	2.30
2		5.06	3.30	2.60	1.90	1.90	2.10	2.45	2.30
3		4.89	3.28	2.67	1.90	1.90	2.15	2.45	2.30
4		4.73	3.23	2.65	1.90	1.90	2.15	2.45	2.30
5		4.48	3.20	2.30	1.90	1.90	2.20	2.45	2.30
6		4.40	3.10	2.60	1.90	1.90	2.20	2.42	2.30
7		4.27	3.05	2.30	1.90	1.90	2.25	2.40	2.35
8		4.23	2.97	2.35	1.90	1.90	2.25	2.40	2.40
9		4.23	2.95	2.40	1.90	1.90	2.30	2.40	2.40
10		4.14	2.97	2.30	1.90	1.90	2.30	2.35	2.40
11			2.90	2.35	1.90	1.90	2.35	2.35	2.40
12		4.21	2.90	2.35	1.90	2.00	2.30	2.35	2.40
13		4.20	2.95	2.35	1.90	2.00	2.40	2.35	2.40
14	7.06	4.22	2.80	2.35	1.90	2.00	2.30	2.30	2.40
15	6.86	4.19	2.70	2.30	1.90	2.00	2.40	2.30	2.35
16		4.00	2.67	2.15	1.90	2.10	2.40	2.30	2.35
17		4.00	2.49	2.15	1.90	2.10	2.40	2.30	2.35
18		3.97	2.48	2.10	1.90	2.10	2.40	2.30	2.40
19		3.95	2.47	2.05	1.90	2.10	2.40	2.30	2.40
20		3.92	2.48	2.05	1.90	2.10	2.45	2.30	2.40
21		3.85	2.48	2.00	1.90	2.10	2.45	2.30	2.40
22		3.80	2.48	2.00	1.90	2.10	2.45	2.30	2.40
23	5.46	3.80	2.50	2.00	1.90	2.10	2.45	2.30	2.45
24		3.75	2.50	1.97	1.90	2.10	2.45	2.35	2.45
25		3.62	2.50	1.90	1.90	2.10	2.45	2.35	2.45
26	4.81	3.54	2.51	1.90	1.90	2.10	2.45	2.30	2.50
27	4.73	3.50	2.51	1.90	1.90	2.10	2.45	2.30	2.50
28	4.56	3.48	2.51	1.95	1.90	2.10	2.45	2.30	2.60
29	5.06	3.40	2.50	1.92	1.90	2.15	2.45	2.30	2.65
30	4.98	3.35	2.50	1.90	1.90	2.15	2.40	2.30	2.70
31		3.30		1.90	1.90		2.40		2.75

Rating table for Willow Creek near Dell, Oreg., from April 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.90	0.5	3.20	59	4.50	226	6.60	776
2.00	1.5	3.30	68	4.60	244	6.80	852
2.10	3	3.40	78	4.70	262	7.00	930
2.20	5	3.50	88	4.80	280	7.20	1,010
2.30	7	3.60	98	4.90	300	7.40	1,090
2.40	11	3.70	110	5.00	320	7.60	1,170
2.50	15	3.80	122	5.20	362	7.80	1,250
2.60	20	3.90	134	5.40	408	8.00	1,330
2.70	26	4.00	148	5.60	456	8.50	1,530
2.80	32	4.10	162	5.80	511	9.00	1,730
2.90	38	4.20	177	6.00	570	9.50	1,930
3.00	44	4.30	193	6.20	636	10.00	2,130
3.10	51	4.40	209	6.40	704		

The above table is applicable only for open-channel conditions. It is based upon 8 discharge measurements made during 1904. It is well defined between gage heights 2.00 feet and 7.10 feet. The table has been extended beyond these limits. Above gage height 6.90 feet the rating curve is a tangent, the difference being 40 per tenth.

Estimated monthly discharge of Willow Creek near Dell, Oreg., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January [a]			10.0	615
February [a]			221	12,710
March [a]			783	48,140
April [a]			624	37,130
May	332	68	163	10,020
June	68	14	31.7	1,886
July	24	.5	6.87	422
August	.5	.5	.50	31
September	4	.5	1.95	116
October	13	3	9.42	579
November	13	7	8.90	530
December	29	7	12.2	750
The year			156	112,900

[a] Estimated.

WEISER RIVER NEAR WEISER, IDAHO.

The drainage basin of this river is mountainous and rocky, in contrast to the well-wooded areas of the Boise and Payette basins, and the effect is shown in the high flood discharges and low summer flow. A number of small ditches utilize considerable water from this river, but the principal canal is the Galloway canal, which irrigates lands of the Weiser irrigation district north of Weiser. Above this canal is a bench country susceptible of cultivation if water could be brought to it.

The station was established December 6, 1894, by A. P. Davis. It is located on J. W. Lane's ranch in the canyon of the river about 10 miles above Weiser, Idaho. The gage rod, which was installed in 1898, was covered during the process of grading for the roadbed of the Pacific and Idaho Northern Railroad, a line intended to run from Weiser to the mining country in the mountainous district to the north. The present gage was installed October 31, 1899, at a point 100 feet above the old gage on the right bank. It is a 4 by 4 inch inclined timber, 12 feet long, bolted to the rock bluff. One foot measured vertically equals 1.15 feet measured along the gage. The gage is read once each day by Mrs. Annie T. Lane. Discharge measurements are made from a cable and car about 300 feet downstream from the gage. The initial point for soundings is 10 feet from the cable support on the right bank. The channel is straight for 300 feet above and below the station. The current is sluggish. The right bank is high and rocky and is not liable to overflow. The left bank is low and will overflow for 100 feet. Both banks are without trees, but brush grows on that part of the left bank liable to overflow. There is but one channel at all stages. The bed of the stream is composed of gravel, free from vegetation, and not liable to change. Bench mark No. 1 is the highest point of a rock 40 feet southwest of the south anchorage of the cable. Its elevation is 19.54 feet above the zero of the gage. Bench mark No. 2 is the highest point of a rock 60 feet southwest of the cable anchorage on the right bank. Its elevation is 25.16 feet above the zero of the gage. This station was discontinued December 31, 1904.

The observations at this station during 1904 have been made under the direction of D. W. Ross, district engineer.

Mean daily gage height, in feet, of Weiser River near Weiser, Idaho, for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.2	2.1	4.8	5.5	4.7	4.4	2.2	0.7	0.5	0.4	0.7	0.6
2	1.2	2.1	6.25	5.4	4.6	4.4	2.3	.6	.5	.6	.7	.6
3	1.2	2.1	6.15	5.4	5.0	4.4	2.2	.6	.5	.6	.7	.6
4	1.2	2.1	4.4	5.8	4.9	4.4	2.2	.6	.5	.6	.7	.6
5	1.2	2.1	4.0	5.5	4.7	4.3	2.1	.6	.5	.5	.7	.6
6	1.2	2.1	5.1	5.5	4.7	4.3	2.0	.7	.5	.6	.7	.6
7	1.2	2.1	8.0	5.5	4.7	4.0	1.9	.7	.5	.4	.7	.6
8	1.0	2.1	10.5	5.0	4.7	4.0	1.9	.6	.4	.6	.7	.6
9	1.0	2.1	9.9	5.0	4.8	4.0	1.9	.5	.4	.8	.7	.6
10	1.2	2.1	7.95	5.25	4.6	4.0	1.8	.5	.3	.8	.7	.6
11	1.2	2.1	8.9	6.1	4.6	3.8	1.7	.5	.3	.9	.7	.6
12	1.2	2.1	7.0	6.55	4.6	3.5	1.7	.5	.3	.9	.7	.6
13	1.2	2.1	5.8	7.0	4.6	3.3	1.7	.4	.3	.8	.7	.6
14	1.2	2.1	5.6	7.35	4.6	3.3	1.6	.5	.3	.8	.7	.6
15	1.2	2.1	6.5	7.55	4.7	3.3	1.5	.5	.3	.8	.7	.6
16	1.2	2.5	5.7	7.8	4.7	3.4	1.5	.5	.3	.8	.7	.6
17	1.3	6.65	7.0	7.5	4.7	3.5	1.5	.5	.3	.8	.7	.7
18	1.4	5.45	6.45	6.8	4.7	3.6	1.4	.5	.3	.8	.7	.7
19	1.6	5.2	9.0	6.7	4.7	3.5	1.3	.4	.3	.8	.7	.7
20	1.6	4.0	8.4	6.85	4.9	3.2	1.2	.4	.3	.8	.7	.7
21	1.7	4.0	6.0	7.0	5.05	3.2	1.2	.4	.3	.8	.7	.7
22	1.8	4.0	5.6	6.1	5.5	3.0	1.1	.4	.3	.8	.7	.7
23	2.0	4.4	5.0	5.5	5.5	3.0	1.0	.4	.3	.8	.7	.7
24	2.0	5.8	4.5	5.0	5.5	2.9	1.0	.4	.3	.7	.7	.7
25	2.2	5.7	4.4	4.7	5.4	2.7	1.0	.4	.3	.7	.7	.8
26	2.2	7.3	4.4	4.7	4.9	2.5	.9	.4	.3	.7	.7	.8
27	2.2	6.4	4.0	5.15	4.5	2.5	.8	.3	.3	.7	.7	.8
28	2.2	5.4	4.35	5.65	4.5	2.4	.8	.5	.3	.7	.7	.8
29	2.2	4.9	7.2	5.3	4.4	2.4	.7	.6	.3	.7	.7	.8
30	2.1	.....	7.5	5.0	4.4	2.3	.7	.8	.3	.7	.7	.8
31	2.1	.....	6.0	.....	4.4	.....	.7	.6	.....	.7	.....	.8

Rating table for Weiser River near Weiser, Idaho, from January 1, 1902, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.2	39	2.2	875	4.2	3,125	6.2	5,825
.4	71	2.4	1,050	4.4	3,395	6.4	6,095
.6	105	2.6	1,235	4.6	3,665	6.6	6,365
.8	150	2.8	1,425	4.8	3,935	6.8	6,635
1.0	215	3.0	1,625	5.0	4,205	7.0	6,900
1.2	290	3.2	1,840	5.2	4,475	7.5	7,575
1.4	375	3.4	2,075	5.4	4,745	8.0	8,250
1.6	470	3.6	2,325	5.6	5,015	8.5	8,925
1.8	585	3.8	2,585	5.8	5,285	9.0	9,600
2.0	720	4.0	2,855	6.0	5,555	9.5	10,275

The above table is applicable for open-channel conditions only. It is based upon discharge measurement made during 1902 and 1903, and is fairly well defined.

Estimated monthly discharge of Weiser River near Weiser, Idaho, for 1904.

[Drainage area, 1,670 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	875	215	473	29,080	0.283	0.326
February	7,305	798	2,532	145,600	1.52	1.64
March	11,620	2,855	6,004	369,200	3.60	4.15
April	7,980	3,800	5,467	325,300	3.27	3.65
May	4,880	3,395	3,911	240,500	2.34	2.70
June	3,395	962	2,204	131,100	1.32	1.47
July	962	127	453	27,850	.271	.312
August	150	55	91.6	5,632	.055	.063
September	88	55	63.8	3,796	.038	.042
October	182	71	132	8,116	.079	.091
November	127	127	127	7,557	.076	.085
December	150	105	121	7,440	.072	.083
The year	11,620	55	1,798	1,301,000	1.08	14.61

POWDER RIVER NEAR BAKER CITY, OREG.

This station was established December 20, 1903, by John H. Lewis. It is located 10 miles above Baker City, Oreg., and one-fourth mile below Salisbury, a station on the Sumpter Valley Railroad. A plain staff gage, graduated to feet and tenths, is nailed in a vertical position to a tree on the left bank, about 400 feet below the house of R. M. Garrett, who reads the gage twice each day. Discharge measurements are made from a wagon bridge having a single span of about 50 feet. The initial point for soundings is at the left end of the bridge. Five-foot intervals are marked on the bridge by means of 20-penny nails. The channel is straight for about 75 feet above and 100 feet below the station, and the current is swift. Both banks are low, timbered, and liable to overflow. The bed of the stream is composed of gravel, free from vegetation, and is permanent. There is but one channel at all stages. The bench mark is a group of three 30-penny nails driven into a large cottonwood tree which stands on the left bank of the stream 35 feet below the gage and 6 feet above the end of the bridge. Its elevation is 8.00 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurements of Powder River near Baker City, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
March 16	J. H. Lewis	39	53	3.10	2.95	162
May 7	W. C. Sawyer	40	110	5.20	4.30	572
May 11	Murphy and Sawyer	40	118	5.60	4.56	660
July 2	W. C. Sawyer	38	50	2.69	2.92	133
September 22 [a]	do	16	8.4	.94	1.74	7.9
December 6 [b]	do	9	10	1.84	2.15	18.4

[a] Wading. [b] Channel partly frozen.

Mean daily gage height, in feet, of Powder River near Baker City, Oreg., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.24	2.40	2.75	3.15	4.45	4.45	2.95	2.25	2.15	1.80	2.15	2.10
2	2.24	2.45	2.70	3.20	4.55	4.30	2.95	2.20	2.05	1.75	2.15	2.05
3	2.24	2.44	2.80	3.35	4.45	4.40	2.90	2.20	2.05	1.80	2.15	2.00
4	2.24	2.45	2.40	3.60	4.60	4.35	2.80	2.20	2.00	1.85	2.10	1.95
5	2.24	2.42	2.48	3.45	4.55	4.30	2.90	2.15	2.00	1.85	2.15	1.90
6	2.24	2.45	2.75	4.35	4.45	4.50	2.75	2.10	1.95	1.80	2.10	2.15
7	2.24	2.48	3.40	4.35	4.40	4.50	2.85	2.15	1.95	1.85	2.10	2.20
8	2.24	2.40	3.20	4.80	4.45	4.25	2.85	2.15	1.95	1.75	2.05	2.15
9	2.24	2.52	2.95	5.30	4.35	4.35	2.90	2.15	1.90	1.80	2.00	2.20
10	2.24	2.62	3.05	5.40	4.45	4.10	2.75	2.10	1.90	1.90	2.00	2.15
11	2.24	2.58	3.00	6.15	4.55	3.95	2.70	2.05	1.90	2.15	2.05	1.95
12	2.24	2.68	2.90	6.90	4.55	3.75	2.65	2.10	1.85	2.25	2.05	1.95
13	2.24	2.78	2.85	6.45	4.60	3.80	2.60	2.10	1.90	2.20	2.00	2.00
14	2.24	2.65	4.20	7.30	4.50	3.80	2.60	2.05	1.85	2.15	2.00	2.05
15	2.24	2.75	3.05	7.10	4.50	3.85	2.55	2.05	1.85	2.15	2.00	2.15
16	2.24	3.00	2.90	6.35	4.60	3.95	2.50	2.00	1.70	2.15	2.05	2.05
17	2.24	2.92	3.20	5.85	4.65	3.90	2.45	1.85	1.70	2.15	2.00	2.05
18	2.24	3.00	2.90	5.70	4.70	3.80	2.50	1.85	1.65	2.25	2.00	2.15
19	2.24	2.95	2.70	5.65	4.45	3.80	2.40	1.70	1.45	2.35	2.05	2.15
20	2.24	3.10	3.10	6.20	4.45	3.65	2.35	1.75	1.30	2.30	2.05	2.10
21	2.24	3.15	2.85	5.40	4.70	3.50	2.40	1.75	1.85	2.25	2.05	2.10
22	2.24	3.50	2.80	4.30	5.15	3.40	2.35	1.75	1.80	2.30	2.10	2.10
23	2.24	3.15	3.40	4.85	5.40	3.25	2.30	2.15	1.90	2.15	2.10	2.10
24	2.40	3.35	2.85	4.55	4.55	3.25	2.35	2.05	2.00	2.15	2.10	2.15
25	2.34	3.20	2.75	4.35	4.65	3.10	2.30	2.10	2.00	2.15	2.15	2.05
26	2.36	3.17	2.70	4.57	4.55	3.05	2.30	2.15	2.10	2.15	2.15	1.95
27	2.40	3.25	2.50	4.70	4.45	3.05	2.35	2.15	2.05	2.20	2.10	2.00
28	2.39	2.95	2.60	5.10	4.50	2.90	2.25	2.20	2.00	2.20	2.10	2.00
29	2.35	2.95	3.00	5.55	4.50	2.80	2.25	2.20	2.00	2.10	2.10	2.00
30	2.42	.....	2.95	4.90	4.50	2.95	2.30	2.20	1.95	2.15	2.10	2.05
31	2.42	.....	2.95	.....	4.50	.....	2.25	2.30	.....	2.15	.....	2.15

Rating table for Powder River near Baker City, Oreg., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.60	4	2.90	140	4.20	537	5.80	1,082
1.70	7	3.00	161	4.30	571	6.00	1,150
1.80	11	3.10	184	4.40	605	6.20	1,218
1.90	16	3.20	209	4.50	639	6.40	1,286
2.00	22	3.30	237	4.60	673	6.60	1,354
2.10	30	3.40	267	4.70	707	6.80	1,422
2.20	38	3.50	299	4.80	741	7.00	1,490
2.30	48	3.60	333	4.90	775	7.20	1,558
2.40	60	3.70	367	5.00	810	7.40	1,626
2.50	72	3.80	401	5.20	878	7.60	1,694
2.60	86	3.90	435	5.40	946	7.80	1,762
2.70	102	4.00	469	5.60	1,014	8.00	1,830
2.80	120	4.10	503				

The above table is applicable only for open-channel conditions. It is based upon 7 discharge measurements made during 1903 and 1904. It is fairly well defined between gage heights 1.70 feet and 4.60 feet. The table has been extended beyond these limits. Above gage height 3.50 feet the rating curve is a tangent, the difference being 34 per tenth.

Estimated monthly discharge of Powder River near Baker City, Oreg., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January	62	42	46.2	2,841
February	299	60	133	7,650
March	537	60	154	9,469
April	1,592	196	843	50,160
May	946	588	663	40,770
June	639	120	398	23,680
July	150	43	85.0	5,226
August	48	7	28.8	1,771
September	34	2	17.2	1,024
October	54	9	29.5	1,814
November	34	22	28.0	1,666
December	38	16	27.6	1,697
The year	1,592	2	204	147,800

GRANDE RONDE RIVER AT HILGARD, OREG.

This station was established November 6, 1903, by John H. Lewis. It is located at the county highway bridge one-half mile below the Oregon Railroad and Navigation Company station at Hilgard, Oreg. It is just below the mouth of Five Points Creek, which is the first important tributary above Grande Ronde Valley. There are two dams about 20 miles upstream, used to flood the river during the log-driving season. The gage is a 1 by 4 inch board nailed to a vertical 4 by 6 inch timber, which is driven into the ground at the downstream end of the middle bridge pier and bolted at the upper end to the log pier. J. D. Casey and Jay Hawes read the gage once each day at ordinary stages and twice during floods. Discharge measurements are made from the downstream side of the two-span bridge to which the gage is attached. The bridge is supported by two timber crib abutments and by one middle crib pier. The initial point for soundings is at the point where the end post meets the lower chord of the bridge on the right bank. It is directly over the vertical outer edge of the abutment. The channel is straight for 100 feet above and for 200 feet below the station. At ordinary stages all the water passes under the right span, which has a length of 70 feet from the right abutment to the middle pier. At high water the water also passes under the shorter span, which has a length of 52 feet from the left abutment to the middle pier. The right bank is low, but is not liable to overflow. The left bank is low and will overflow only at a few points above the bridge. The bed of the stream is composed of sand and clay, free from vegetation and bowlders. It is permanent under the main span, but is liable to shift in the high-water channel under the shorter span. Bench mark No. 1 is the head of a bolt through the lower chord of the bridge 7.5 feet from the timber to which the gage is attached. Its elevation is 13.80 feet above the zero of the gage. Bench mark No. 2, established July 15, 1904, is a square chisel draft and the letters "U. S. B. M." cut in the top of a rock 200 feet from the right bank, 150 feet upstream from the bridge. Its elevation is 12.81 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurements of Grande Ronde River at Hilgard, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 6	W. C. Sawyer	125	457	4.86	5.60	2,223
July 15	do	66	202	.36	2.92	72
July 15	do	67	223	.80	3.25	179
July 23	do	67	200	.39	3.00	79
November 5[a]	do	42	60	.52	2.72	31

[a] Made at bridge 1 mile below.

Mean daily gage height, in feet, of Grande Ronde River at Hilgard, Oreg., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.50	2.70	3.00	4.50	5.60	4.20	3.30	.....	.....	.....	.....	2.80
2	2.50	2.70	2.70	4.80	5.40	4.30	3.30	.....	.....	.....	.....	2.90
3	2.50	2.90	2.90	5.30	5.30	4.20	3.30	.....	.....	.....	.....	2.68
4	2.50	2.80	2.90	5.30	5.20	4.20	3.30	.....	.....	.....	.....	2.50
5	2.50	2.80	3.00	5.20	4.90	4.20	3.30	.....	.....	.....	.....	2.50
6	2.50	2.80	3.20	5.30	5.00	4.20	3.30	.....	.....	.....	.....	3.30
7	2.50	2.70	3.90	5.40	4.80	4.20	3.30	.....	.....	.....	.....	2.80
8	2.50	2.70	5.30	5.40	5.60	4.20	3.30	.....	.....	.....	.....	2.90
9	2.50	2.80	4.60	6.00	4.90	4.10	3.30	.....	.....	.....	2.80	2.75
10	2.50	2.80	4.20	6.50	4.80	4.10	3.30	.....	.....	.....	3.00	2.80
11	2.60	2.80	3.90	6.80	4.90	4.00	3.30	.....	.....	.....	2.80	2.75
12	2.50	2.80	3.80	7.20	4.60	3.90	3.30	.....	.....	.....	2.72	2.72
13	2.50	2.70	3.70	7.40	4.50	3.90	3.30	.....	.....	.....	2.65	2.75
14	2.50	2.80	3.60	7.50	4.60	3.80	3.30	.....	.....	.....	2.70	2.90
15	2.50	2.90	3.90	7.40	4.80	3.70	3.20	.....	.....	.....	2.70	2.80
16	2.50	2.90	3.80	7.00	4.80	3.70	3.20	.....	.....	.....	2.70	2.80
17	2.40	2.90	4.00	6.80	4.70	3.60	.....	.....	.....	.....	2.70	2.80
18	2.40	2.90	4.20	6.70	4.80	3.50	.....	.....	.....	.....	2.70	2.90
19	2.40	2.90	4.60	6.60	4.70	3.50	.....	.....	.....	.....	2.65	2.85
20	2.40	2.90	4.30	6.30	4.70	3.40	.....	.....	.....	.....	2.65	2.90
21	2.50	3.00	3.90	6.00	4.80	3.30	.....	.....	.....	.....	2.62	2.85
22	2.50	3.30	3.70	5.80	4.80	3.30	.....	.....	.....	.....	2.95	2.85
23	2.50	3.50	3.60	5.70	4.70	3.30	.....	.....	.....	.....	2.68	2.82
24	2.60	3.40	3.50	5.60	4.70	3.30	.....	.....	.....	.....	2.62	2.78
25	2.60	3.30	3.40	5.60	4.60	3.30	.....	.....	.....	.....	2.98	2.85
26	2.60	3.20	3.30	5.70	4.40	3.30	.....	.....	.....	.....	2.68	2.75
27	2.60	4.00	3.20	5.90	4.30	3.30	.....	.....	.....	.....	2.62	2.75
28	2.60	2.90	3.60	6.00	4.20	3.30	.....	.....	.....	.....	2.62	2.80
29	2.60	3.00	4.00	5.90	4.30	3.30	.....	.....	.....	.....	2.95	2.85
30	2.60	.....	4.60	5.80	4.30	3.30	.....	.....	.....	.....	2.80	3.00
31	2.60	.....	4.00	.....	4.30	.....	.....	.....	.....	.....	.....	3.25

Rating table for Grande Ronde River at Hilgard, Oreg., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.50	14	3.70	386	4.80	1,275	5.90	2,592
2.60	19	3.80	444	4.90	1,384	6.00	2,717
2.70	28	3.90	507	5.00	1,495	6.20	2,969
2.80	39	4.00	574	5.10	1,608	6.40	3,221
2.90	57	4.10	645	5.20	1,725	6.60	3,473
3.00	83	4.20	720	5.30	1,846	6.80	3,725
3.10	116	4.30	799	5.40	1,968	7.00	3,977
3.20	153	4.40	883	5.50	2,092	7.20	4,229
3.30	194	4.50	974	5.60	2,216	7.40	4,481
3.40	238	4.60	1,069	5.70	2,341	7.60	4,733
3.50	284	4.70	1,170	5.80	2,466	7.80	4,985
3.60	333						

The above table is applicable only for open-channel conditions. It is based upon 5 discharge measurements made during 1904. It is well defined between gage heights 2.70 feet and 3.30 feet. The table has been extended beyond these limits.

Estimated monthly discharge of Grande Ronde River at Hilgard, Oreg., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January	19	12	15.2	935
February	574	28	93.5	5,378
March	1,846	28	485	29,820
April	4,607	974	2,786	165,800
May	2,216	720	1,270	78,090
June	799	194	434	25,820
July 1–16	194	153	189	5,998
November 9–30	83	21	35.9	1,566
December	194	14	50.6	3,111
The period				316,500

GRANDE RONDE RIVER AT ELGIN, OREG.

This station was established November 20, 1903, by John H. Lewis. It is located at the county bridge on the road from Elgin to Wallowa, Oreg., and is one-fourth mile east of the railroad station. It is at

the lower end of the Grande Ronde Valley. The lower section of the original gage, reading from zero to 2 feet, was a 2 by 4 inch rod driven into the mud on the upstream side of the vertical steel caisson of the left pier. From 2 to 9 feet the gage was painted on the side of the caisson. On July 21, 1904, a standard chain gage was attached to the upstream side of the bridge, near the center of the stream. The length of the chain from the end of the weight to the marker is 22.00 feet. It is read once each day by John Graham. Discharge measurements are made from the downstream side of the bridge, to which the gage is attached. This bridge has a span between piers of 100 feet, with 130 feet of trestle approach from the left bank and 30 feet of approach from the right bank. The initial point for soundings is on the right bank directly over the center of the bent, 30 feet from the caisson. The channel is curved above a point 30 feet above the bridge, and is straight for 200 feet below. The right bank is high, rocky, free from vegetation, and will not overflow. The left bank is low, free from vegetation, and will overflow only under the trestle approach. The bed of the stream is uneven, covered with large bowlders, and is free from vegetation. It is not liable to shift. The channel is broken by the piers and the trestle bents at high water. The bench mark is the top surface of the steel caisson directly over the gage. Its elevation is 15.14 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurements of Grande Ronde River at Elgin, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 12	Murphy and Sawyer	160	550	6.30	4.87	3,460
July 22	W. C. Sawyer	89	244	0.85	2.03	209
August 22	do	77	183	0.27	1.48	50
August 22 [a]	do	36	28	2.11	1.48	58
September 28	do	79	214	.52	1.76	111

[a] Made ¼ mile below.

Mean daily gage height, in feet, of Grande Ronde River at Elgin, Oreg., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.80	2.10	3.20	4.40	5.50	4.20	2.50	1.65	1.50	1.70	1.70	.....
2	1.90	2.00	3.20	4.40	5.40	4.30	2.40	1.65	1.50	1.70	1.70	1.75
3	1.80	2.00	3.00	4.50	5.30	4.30	2.40	1.65	1.55	1.70	1.70	1.75
4	1.90	2.10	3.00	4.50	5.20	4.30	2.40	1.65	1.55	1.60	1.70	1.70
5	1.90	2.20	3.00	4.80	5.20	4.20	2.40	1.65	1.55	1.60	1.70	1.70
6	1.90	2.20	3.40	5.00	5.10	4.10	2.30	1.60	1.55	1.60	1.70	1.85
7	1.90	2.20	3.50	5.00	5.10	4.20	2.30	1.60	1.55	1.60	1.75	1.75

Mean daily gage height, in feet, of Grande Ronde River at Elgin, Oreg., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
8	1.90	2.10	4.90	5.00	5.00	4.10	2.40	1.60	1.50	1.60	1.75	1.75
9	1.80	2.00	4.80	5.20	4.90	4.10	2.50	1.60	1.50	1.65	1.70	1.65
10	1.70	1.90	4.80	5.70	4.90	4.10	2.50	1.60	1.50	1.75	1.70	1.70
11	1.90	1.80	4.80	6.20	4.90	4.00	2.50	1.60	1.55	1.80	1.70	1.70
12	1.90	1.90	4.60	6.50	4.90	3.90	2.50	1.60	1.45	1.80	1.80	1.70
13	1.90	1.90	4.40	6.80	4.90	3.80	2.40	1.55	1.45	1.80	.....	1.75
14	2.00	2.10	4.20	7.00	4.90	3.70	2.40	1.55	1.50	1.85	1.70	1.80
15	2.10	2.20	4.10	7.60	4.90	3.70	2.40	1.55	1.50	1.85	1.70	1.80
16	2.20	3.00	4.10	7.60	4.90	3.60	2.30	1.50	1.50	1.85	1.80	1.70
17	2.40	3.00	4.10	7.60	4.80	3.60	2.30	1.50	1.50	1.90	1.75	1.70
18	2.20	2.90	4.10	7.60	4.80	3.60	2.20	1.50	1.50	2.00	1.70	1.75
19	2.10	2.70	4.20	7.60	4.80	3.60	2.10	1.50	1.45	1.90	1.70	1.80
20	2.10	2.70	4.30	7.20	4.80	3.50	2.00	1.50	1.45	1.80	1.75	1.80
21	1.80	2.70	4.40	7.00	4.80	3.40	2.00	1.45	1.45	1.75	1.75	1.80
22	2.10	2.70	4.30	6.80	4.80	3.20	2.00	1.45	1.45	1.75	1.75	1.75
23	2.20	3.20	4.10	6.60	4.80	3.10	2.00	1.45	1.50	1.75	1.70	1.75
24	2.10	3.70	3.90	6.20	4.80	3.00	1.95	1.45	1.50	1.80	1.75	1.80
25	2.00	3.50	3.80	5.90	4.80	2.90	1.90	1.45	1.55	1.80	1.70	1.80
26	2.20	3.50	3.60	5.80	4.80	2.80	1.85	1.45	1.65	1.75	1.75	[a] 1.60
27	2.30	3.50	3.40	5.70	4.70	2.80	1.80	1.45	1.65	1.75	1.75	[a] 1.70
28	2.20	3.20	3.50	5.60	4.60	2.80	1.75	1.50	1.80	1.75	1.75	[a] 1.85
29	2.20	3.10	3.70	5.60	4.40	2.70	1.80	1.55	1.80	1.70	1.75	[a] 1.85
30	2.20	.....	4.30	5.60	4.20	2.60	1.75	1.55	1.80	1.70	1.75	[a] 1.70
31	2.20	.....	4.50	.....	4.20	.....	1.70	1.55	.....	1.70	.....	[a] 1.80

[a] Gage heights December 26 to 31, inclusive, are approximate, owing to ice.

Rating table for Grande Ronde River at Elgin, Oreg., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.50	53	2.80	589	4.10	2,114	5.80	5,127
1.60	74	2.90	663	4.20	2,277	6.00	5,485
1.70	99	3.00	743	4.30	2,446	6.20	5,843
1.80	128	3.10	829	4.40	2,621	6.40	6,201
1.90	158	3.20	923	4.50	2,800	6.60	6,559
2.00	190	3.30	1,025	4.60	2,979	6.80	6,917
2.10	225	3.40	1,135	4.70	3,158	7.00	7,275
2.20	264	3.50	1,253	4.80	3,337	7.20	7,633
2.30	307	3.60	1,379	4.90	3,516	7.40	7,991
2.40	354	3.70	1,513	5.00	3,695	7.60	8,349
2.50	405	3.80	1,655	5.20	4,053	7.80	8,707
2.60	462	3.90	1,804	5.40	4,411	8.00	9,065
2.70	523	4.00	1,957	5.60	4,769		

The above table is applicable only for open-channel conditions. It is based upon 5 discharge measurements made during 1904. It is not well defined. Above gage height 4.40 feet the rating curve is a tangent, the difference being 179 per tenth.

Estimated monthly discharge of Grande Ronde River at Elgin, Oreg., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January	354	99	204	12,540
February	1,513	128	528	30,370
March	3,516	743	2,007	123,400
April	8,349	2,621	5,525	328,800
May	4,590	2,277	3,471	213,400
June	2,446	462	1,496	89,020
July	405	99	271	16,660
August	86	44	63.1	3,880
September	128	44	63.2	3,760
October	190	74	114	7,010
November	128	99	107	6,367
December	143	74	114	7,010
The year	8,349	44	1,168	842,200

GRANDE RONDE RIVER AT ZINDEL, WASH.

This station was established June 30, 1904, by W. G. Steward. It is located at Zindel Ferry, 2 miles above the mouth of the river and 1½ miles below Joseph Creek. The gage is located just below the ferry on the left bank. It is an inclined fir log, hewed flat on the top face and graduated to vertical feet and tenths, from 2.5 to 8.9 feet. The gage is read daily by M. W. Zindel, who is paid by the Lewiston Water and Power Company. Discharge measurements are made from the ferryboat. The distances are measured on the stay-line used for the ferry. The initial point is an 8-penny nail in a pine tree 30 feet south of the cable post on the right bank. The channel is curved above the station, but straight for 1,200 feet below. There are rapids 600 feet above and also 1,200 feet below the station. The right bank is rocky and slopes gradually. It is liable to overflow at extreme high water. The left bank is high and rocky, and not liable to overflow. The bed is rocky and permanent. It is fairly even for soundings. There is one channel at all stages. The bench mark is located 29 feet downstream from the gage.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurements of Grande Ronde River at Zindel, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
June 29	W. G. Steward	208	1,182	3.18	4.32	3,762
August 11	C. M. Hulburt	192	801	1.40	2.58	1,118

Mean daily gage height, in feet, of Grande Ronde River at Zindel, Wash., for 1904.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	5.00	2.90	2.40	2.30	2.30	2.30
2	.....	5.00	2.85	2.35	2.30	2.30	2.25
3	.....	4.65	2.80	2.35	2.30	2.30	2.25
4	.....	4.70	2.75	2.30	2.25	2.30	2.15
5	.....	4.65	2.70	2.30	2.20	2.25	2.15
6	.....	4.60	2.70	2.29	2.25	2.25	2.15
7	.....	4.60	2.70	2.28	2.30	2.25	2.25
8	.....	4.55	2.63	2.25	2.30	2.25	2.30
9	.....	4.45	2.65	2.23	2.35	2.25	2.40
10	.....	4.40	2.60	2.21	2.35	2.25	2.30
11	.....	4.30	2.00	2.20	2.35	2.25	2.25
12	.....	4.25	2.00	2.20	2.35	2.30	2.25
13	.....	4.20	2.55	2.20	2.40	2.30	2.30
14	.....	4.05	2.55	2.20	2.45	2.25	2.30
15	.....	3.90	2.50	2.20	2.60	2.25	2.35
16	.....	4.00	2.50	2.20	2.50	2.25	2.40
17	.....	3.90	2.50	2.20	2.50	2.25	2.35
18	.....	3.90	2.50	2.20	2.45	2.25	2.35
19	.....	3.80	2.50	2.20	2.45	2.25	2.35
20	.....	3.60	2.50	2.20	2.45	2.25	2.30
21	.....	3.55	2.40	2.20	2.45	2.30	2.30
22	.....	3.60	2.40	2.20	2.40	2.30	2.40
23	.....	3.55	2.35	2.20	2.40	2.30	2.50
24	.....	3.50	2.30	2.20	2.40	2.25	2.15
25	.....	3.50	2.30	2.20	2.40	2.25	2.30
26	.....	3.40	2.30	2.35	2.35	2.25	2.20
27	.....	3.25	2.30	2.40	2.35	2.30	2.20
28	.....	3.30	2.30	2.30	2.30	2.30	2.25
29	4.32	3.30	2.45	2.30	2.30	2.30	2.30
30	4.18	3.10	2.50	2.30	2.30	2.30	2.60
31	.....	3.00	2.50	.....	2.30	.....	2.65

WALLOWA RIVER NEAR JOSEPH, OREG.

This station was established November 12, 1903, by John H. Lewis. The gage is located on Wallowa Lake near its outlet. It is a vertical 2 by 6 inch board fastened to a log pier which extends into the lake. It reads from zero to 5 feet. It is read once each day by F. L. Bedingfield. Discharge measurements are made from a footbridge about 500 feet below the outlet of Wallowa Lake and 1¼ miles above Joseph, Oreg. The bridge has a single span of 50 feet. The initial point for soundings is the end of the upstream log supporting the footbridge on the left bank. The channel is straight for 100 feet above and for 75 feet below the station. The right bank is liable to overflow at high water for about 30 feet, at which point it becomes steep. The left bank will overflow for about 20 feet at high water. Both banks are timbered.

At the bridge the bed of the stream is composed of large bowlders, free from vegetation, and is not liable to shift. There is but one channel at all stages. The direction of the wind is liable to affect both the gage readings on the lake and the discharge. The bench mark is a square chisel draft and the letters "U. S. G. S. B. M." painted in black on a granite bowlder on the beach, under a large cottonwood tree, about 65 feet northwest of the gage. Its elevation is 4.95 feet.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurements of Wallowa River near Joseph, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
July 18	W. C. Sawyer	40	102	3.94	2.98	402
July 18[a]	do	60	194	2.13	2.97	413
August 18	do	35	67	3.50	2.38	234
September 26	do	31	36	2.30	1.53	84
September 26[a]	do	75	78	1.21	1.54	95

[a] At footbridge.

Mean daily gage height, in feet, of Wallowa River near Joseph, Oreg., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.45	1.10	.....	1.40	2.00	3.20	3.80	2.70	.....	1.50	.....	1.30
2	1.45	1.20	.....	1.45	2.00	3.20	3.80	2.70	.....	1.50	1.40	1.30
3	.....	.....	.....	1.35	2.00	3.20	3.95	2.60	.....	1.50	1.40	1.30
4	.....	1.25	.....	1.33	2.00	3.20	3.95	2.60	.....	1.50	1.40	1.30
5	.....	1.25	.....	1.30	2.00	3.20	3.90	.....	.....	1.50	1.40	1.30
6	.....	.....	.....	1.30	2.00	3.25	3.90	.....	.....	1.50	1.40	1.30
7	.....	1.20	.....	1.30	2.00	3.25	3.90	.....	.....	1.50	.....	1.30
8	.....	1.20	1.45	1.30	2.00	3.25	3.85	.....	.....	1.50	1.30	1.30
9	.....	1.20	1.45	1.30	2.00	3.30	3.80	.....	.....	1.60	1.30	1.30
10	1.42	.....	.....	1.33	2.00	3.30	3.80	.....	.....	.....	1.30	1.30
11	1.42	.....	.....	1.37	2.07	3.30	3.75	.....	.....	1.40	1.30	1.30
12	1.40	1.25	.....	1.40	2.10	.....	3.70	.....	.....	1.60	1.30	1.30
13	1.40	1.25	.....	1.45	2.15	.....	3.65	.....	.....	1.60	1.30	.....
14	1.40	1.25	1.50	1.52	2.20	.....	3.50	.....	.....	1.60	.....	.....
15	1.40	1.25	1.40	1.70	2.25	3.30	3.45	.....	.....	1.60	1.30	1.30
16	1.40	1.35	1.40	1.80	2.30	3.40	.....	.....	.....	1.60	1.30	1.30
17	.....	1.35	1.40	1.85	2.38	3.50	3.10	2.38	.....	1.60	.....	1.30
18	.....	1.40	1.40	1.90	2.50	3.60	3.00	2.40	.....	1.60	1.30	1.30
19	.....	1.45	1.45	1.95	2.58	3.70	2.90	.....	.....	1.50	1.30	1.30
20	.....	1.45	1.45	2.00	2.60	3.80	2.80	.....	.....	1.50	.....	1.20
21	.....	1.40	.....	2.00	2.65	3.80	2.85	.....	.....	1.50	.....	1.30
22	.....	1.40	.....	2.00	2.75	3.80	2.80	.....	.....	1.50	1.30	1.30
23	.....	1.40	1.45	2.00	2.90	3.70	2.95	.....	.....	1.50	1.30	.....
24	1.40	1.40	1.45	2.00	3.05	3.60	3.00	.....	.....	1.50	1.30	1.30
25	1.35	1.40	1.40	1.95	3.10	3.55	3.10	.....	1.54	1.50	1.30	1.30
26	1.35	1.35	1.40	1.95	3.10	3.50	3.50	.....	1.53	1.40	1.30	1.30
27	1.30	.....	1.45	.....	3.05	3.50	3.00	.....	.....	1.40	1.30	1.20
28	1.25	.....	1.40	1.95	.....	3.55	3.00	.....	1.50	1.40	.....	1.20
29	1.25	.....	1.50	1.95	3.05	3.65	2.95	.....	1.60	1.40	1.30	.....
30	1.25	.....	1.50	1.95	3.05	3.70	2.90	.....	1.50	.....	.....	1.40
31	1.25	.....	1.45	.....	3.15	.....	2.80	.....	.....	1.40	.....	1.40

Rating table for Wallowa River near Joseph, Oreg., from November 13, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.20	53	2.00	157	2.70	315	3.40	541
1.30	63	2.10	175	2.80	344	3.50	575
1.40	73	2.20	195	2.90	374	3.60	609
1.50	85	2.30	216	3.00	406	3.70	643
1.60	97	2.40	238	3.10	439	3.80	677
1.70	110	2.50	262	3.20	473	3.90	711
1.80	125	2.60	283	3.30	507	4.00	745
1.90	141						

The above table is applicable only for open-channel conditions. It is based upon 6 discharge measurements made during 1903 and 1904. It is well defined between gage heights 1.50 feet and 3.00 feet. The table has been extended beyond these limits.

Estimated monthly discharge of Wallowa River near Joseph, Oreg., for 1903 and 1904.

Month.	Discharge in second-feet.[a]			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
1903.				
November 13–30	103	85	94.2	3,363
December	97	77	86.0	5,288
1904.				
January	79	58	72.0	4,427
February	79	45	63.1	3,630
March	85	73	78.0	4,796
April	157	63	110	6,545
May	456	157	266	16,360
June	677	473	555	33,020
July	728	344	534	32,830
August	315	185	240	14,760
September	185	85	133	7,914
October	97	73	85.4	5,251
November	73	63	65.3	3,889
December	73	53	62.7	3,855
The year	728	45	189	137,300

[a] Discharge interpolated for missing gage heights.

WALLOWA RIVER NEAR WALLOWA, OREG.

This station was established November 14, 1903, by John H. Lewis. It is located at the county bridge, 1½ miles below Wallowa, Oreg., and one-fourth mile below the mouth of Bear Creek. A small irrigation

ditch which carries about 2 second-feet takes water from the river about 300 feet above the bridge on the right bank. The gage is a vertical 2 by 6 inch timber nailed to the downstream side of the timber crib pier on the right bank. Its location is such that it is protected by the pier from drift. It is read once each day by L. S. Johnson. Discharge measurements are made from the upstream side of the bridge to which the gage is attached. The initial point for soundings is the left end of the lower chord on the upstream side of the bridge. The channel is straight for 400 feet above and for 600 feet below the station. The current is swift. Both banks are low, wooded, and not liable to overflow. The bed of the stream is composed of gravel, free from vegetation, and is not liable to shift. There is but one channel at low water. At high water the channel is broken by the rock-filled timber crib pier, to which the gage is fastened. Bench mark No. 1 is the head of a 30-penny wire nail driven nearly flush with the top of the crib, 2 inches from the edge, near the gage. Its elevation is 6.60 feet above the zero of the gage. Bench mark No. 2 is a square chisel draft on top of a rock near rail fence across the ditch 50 feet from the right end of the bridge. Its elevation is 8.10 feet above the gage zero.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurements of Wallowa River near Wallowa, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
July 19	W. C. Sawyer	88	200	5.30	3.09	1,058
August 19	do	84	106	3.60	2.12	379
September 24	do	72	87	3.08	1.82	268

Mean daily gage height, in feet, of Wallowa River near Wallowa, Oreg., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.70	1.70	1.95	2.20	2.70	3.80	4.20	.....	2.10	1.80	1.90	1.90
2	1.70	1.70	1.85	2.30	2.80	3.60	4.10	.....	2.10	1.80	1.90	1.90
3	1.70	1.68	1.85	2.40	2.75	3.60	4.20	.....	2.10	1.80	1.90	1.80
4	1.72	1.70	1.90	2.40	2.80	3.50	4.00	.....	2.10	1.80	1.90	1.70
5	1.75	1.70	1.95	2.50	2.80	3.70	4.00	2.30	2.10	1.80	1.90	1.70
6	1.75	1.72	2.00	2.80	2.70	4.00	4.10	2.30	2.00	2.00	1.90	1.70
7	1.74	1.68	3.02	2.50	2.70	4.00	4.00	2.00	2.00	2.00	1.90	1.70
8	1.78	1.62	3.75	2.50	2.70	3.70	3.90	2.00	2.00	1.90	1.90	1.70
9	1.72	1.56	2.90	2.55	2.75	3.70	4.00	2.20	2.00	1.90	1.90	1.80
10	1.72	1.50	2.60	2.80	2.75	3.70	4.00	2.20	2.00	1.90	1.90	1.70
11	1.74	1.70	2.70	2.80	2.80	3.50	4.00	2.30	2.00	1.90	1.90	1.80
12	1.74	1.88	2.55	2.70	2.90	3.50	3.90	2.20	2.00	2.00	1.90	1.80
13	1.80	1.68	2.45	2.80	2.90	3.50	3.70	2.20	2.00	2.00	1.90	1.80
14	1.80	1.60	2.45	3.50	3.30	3.50	3.50	2.20	1.90	2.00	1.90	1.80
15	1.75	1.68	2.50	3.70	3.00	3.30	3.40	2.20	1.90	2.10	1.90	1.80
16	1.75	2.00	2.30	3.80	3.00	3.90	3.40	2.20	1.90	2.10	1.90	1.80
17	1.80	1.85	2.30	3.50	3.10	3.70	3.20	2.20	1.90	2.10	1.90	1.80
18	1.80	1.60	2.30	3.50	3.30	4.20	3.10	2.20	1.90	2.00	1.90	1.80

Mean daily gage height, in feet, of Wallowa River near Wallowa, Oreg., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
19	1.70	1.70	2.30	3.40	3.30	4.10	3.10	2.10	1.90	2.00	1.90	1.80
20	1.65	1.75	2.30	3.40	3.20	4.00	3.10	2.10	1.80	2.00	1.90	1.80
21	1.60	1.78	2.30	3.20	3.50	3.90	3.20	2.10	1.80	2.00	1.90	1.80
22	1.60	2.40	2.20	3.10	3.70	4.00	3.30	2.10	1.80	2.00	1.90	1.80
23	1.60	2.50	2.20	3.00	4.00	3.70	3.20	2.10	1.80	2.00	1.90	1.80
24	1.60	2.25	2.10	2.80	4.20	3.40	3.20	2.10	1.80	2.00	1.90	1.80
25	1.60	2.20	2.10	2.80	3.80	3.30	3.00	2.10	1.80	2.00	1.90	1.80
26	1.60	2.20	2.55	2.80	3.50	3.20	3.00	2.10	1.80	1.90	1.90	1.80
27	1.60	2.20	2.00	2.90	3.50	3.30	2.90	2.00	1.80	1.90	1.90	1.80
28	1.60	2.00	2.00	2.90	3.50	3.30	2.80	2.20	1.80	1.90	2.00	1.80
29	1.60	2.00	2.40	2.90	3.50	3.50	2.70	2.20	1.80	1.90	1.90	1.80
30	1.60	.....	2.40	2.80	3.70	3.60	2.60	2.20	1.80	1.90	1.90	2.10
31	1.65	.....	2.20	.....	3.20	.....	2.00	2.20	.....	1.90	.....	2.10

Rating table for Wallowa River near Wallowa, Oreg., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.70	226	2.40	512	3.10	1,063	3.70	1,730
1.80	258	2.50	567	3.20	1,169	3.80	1,844
1.90	293	2.60	626	3.30	1,277	3.90	1,958
2.00	331	2.70	693	3.40	1.388	4.00	2,072
2.10	371	2.80	772	3.50	1,502	4.10	2,186
2.20	414	2.90	862	3.60	1,616	4.20	2,300
2.30	461	3.00	960				

The above table is applicable only for open-channel conditions. It is based upon 3 discharge measurements made during 1904. It is well defined between gage heights 1.80 feet and 3.10 feet. The table has been extended beyond these limits.

Estimated monthly discharge of Wallowa River near Wallowa, Oreg., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January	258	197	225	13,840
February	567	172	284	16,340
March	1,787	275	517	31,790
April	1,844	414	923	54,920
May	2,300	693	1,165	71,640
June	2,300	1,169	1,681	100,000
July	2,300	331	1,473	90,570
August [a]	461	331	397	24,410
September	371	258	303	18,030
October	371	258	311	19,120
November	331	293	294	17,490
December	371	226	261	16,050
The year	2,300	172	653	474,200

[a] Discharge interpolated August 1-4.

WALLOWA RIVER NEAR ELGIN, OREG.

This station was established November 18, 1903, by John H. Lewis. It is located at the county highway bridge just below the mouth of Minam River and 12 miles from Elgin, Oreg. The gage is in 2 sections of 2 by 6 inch timber, located under the lower side of the bridge on the left bank. Both sections are held in place by bolts, cemented into the solid rock. The lower or inclined section reads from 1.7 to 3 feet. The upper or vertical section reads from 3 to 10 feet. The gage is read once each day by John McCulloch. Discharge measurements are made from the downstream side of the single-span bridge, to which the gage is attached. On account of the velocity of the water a stay wire is used in making discharge measurements. The initial point for soundings is the end of the bridge rail on the left bank. The channel is straight for 100 feet above and for 1,000 feet below the station. Both banks are high, rocky, not liable to overflow, and without timber or brush. The current is swift. The bed of the stream is composed of gravel, free from vegetation, and not liable to shift. There is but one channel at all stages. Bench mark No. 1 is the highest point of the rock to which the vertical section of the gage is fastened. It is 6 inches from the gage rod and has an elevation of 9.60 feet above the zero of the gage. Bench mark No. 2 is the center of the hole in the rock in which the bolt supporting vertical rod is set. Its elevation is 7.07 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurements of Wallowa River near Elgin, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
July 20	W. C. Sawyer	160	363	4.58	3.70	1,663
August 20	do	147	196	2.90	2.65	568
September 27	do	135	164	2.54	2.35	416

Mean daily gage height, in feet, of Wallowa River near Elgin, Oreg., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.50	2.30	2.90	3.30	3.80	4.80	5.00	3.00	2.60	2.30	2.30	2.30
2	2.60	2.30	2.90	3.40	3.80	5.00	4.80	3.00	2.60	2.30	2.30	2.30
3	2.60	2.30	2.80	3.60	3.80	4.80	4.80	3.00	2.50	2.30	2.30	2.30
4	2.60	2.40	2.80	3.70	4.00	4.70	4.80	3.00	2.50	2.30	2.30	2.30
5	2.50	2.60	2.80	3.80	3.90	4.80	4.70	2.90	2.50	2.30	2.30	2.30
6	2.50	2.50	2.90	4.30	3.80	5.10	4.70	2.90	2.50	2.30	2.30	2.30
7	2.50	2.50	3.70	3.90	3.80	5.00	4.60	2.90	2.50	2.40	2.30	2.30
8	2.50	2.40	5.00	3.80	3.80	4.90	4.60	2.90	2.40	2.50	2.30	2.30
9	2.60	2.40	4.40	4.00	3.80	4.80	4.60	2.80	2.40	2.40	2.30	2.30
10	2.60	2.50	3.90	4.40	3.90	4.70	4.50	2.80	2.40	2.40	2.30	2.30
11	2.60	2.50	3.80	4.80	4.00	4.50	4.40	2.80	2.40	2.40	2.30	2.30
12	2.70	2.60	3.60	4.80	4.00	4.50	4.40	2.80	2.40	2.60	2.30	2.30
13	2.70	2.60	3.40	5.00	4.10	4.50	4.30	2.70	2.40	2.50	2.30	2.30
14	2.70	2.60	3.40	5.20	4.20	4.50	4.10	2.70	2.40	2.50	2.30	2.30
15	2.70	2.60	3.70	5.20	4.20	4.80	4.10	2.70	2.40	2.60	2.30	2.30
16	2.70	2.70	3.40	5.20	4.20	5.00	4.00	2.70	2.40	2.60	2.30	2.30
17	2.70	2.70	3.40	4.80	4.30	5.00	3.80	2.70	2.30	2.50	2.30	2.30
18	2.70	2.50	3.40	4.60	4.50	5.20	3.70	2.70	2.30	2.50	2.30	2.30
19	2.70	2.70	3.40	4.60	4.50	5.00	3.70	2.70	2.30	2.50	2.30	2.30
20	2.30	2.60	3.50	4.60	4.40	4.80	3.70	2.60	2.30	2.40	2.30	2.30
21	2.40	2.60	3.30	4.60	4.60	4.70	3.70	2.60	2.30	2.40	2.30	2.30
22	2.50	3.00	3.20	4.20	5.00	4.70	3.80	2.60	2.30	2.40	2.30	2.30
23	2.50	3.50	3.20	4.10	5.30	4.60	3.80	2.60	2.30	2.40	2.30	2.30
24	2.40	3.90	3.20	3.90	5.40	4.30	3.80	2.60	2.30	2.40	2.30	2.30
25	2.40	3.00	3.20	3.80	5.00	4.30	3.70	2.60	2.30	2.40	2.30	2.30
26	2.30	3.00	2.90	3.80	4.60	4.30	3.60	2.50	2.30	2.40	2.30	2.30
27	2.30	3.30	2.90	3.90	4.60	4.30	3.50	2.60	2.30	2.40	2.30	2.30
28	2.30	3.00	2.90	4.00	4.60	4.30	3.50	2.70	2.30	2.30	2.40	2.30
29	2.30	3.00	3.40	4.00	4.70	4.50	3.30	2.70	2.30	2.30	2.30	2.30
30	2.30	.....	3.60	3.90	4.80	4.60	3.20	2.60	2.30	2.30	2.30	2.30
31	2.30	.....	3.40	.....	4.80	.....	3.10	2.60	.....	2.30	.....	2.30

Rating table for Wallowa River near Elgin, Oreg., from November 21, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.30	386	3.10	926	3.90	1,946	4.70	3,082
2.40	435	3.20	1,027	4.00	2,088	4.80	3,224
2.50	488	3.30	1,137	4.10	2,230	4.90	3,366
2.60	545	3.40	1,256	4.20	2,372	5.00	3,508
2.70	606	3.50	1,384	4.30	2,514	5.10	3,650
2.80	674	3.60	1,520	4.40	2,656	5.20	3,792
2.90	750	3.70	1,662	4.50	2,798	5.30	3,934
3.00	834	3.80	1,804	4.60	2,940	5.40	4,076

The above table is applicable only for open-channel conditions. It is based upon 4 discharge measurements made during 1903 and 1904. It is well defined between gage heights 2.35 feet and 3.70 feet. The table has been extended beyond these limits. Above gage height 3.70 feet the rating curve is a tangent, the difference being 142 per tenth.

Estimated monthly discharge of Wallowa River near Elgin, Oreg., for 1903 and 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
1903.				
November 17-30	1,804	545	999	27,740
December	834	488	652	40,090
1904.				
January	606	386	501	30,800
February	1,946	386	661	38,020
March	3,508	674	1,273	78,270
April	3,792	1,137	2,431	144,700
May	4,076	1,804	2,555	157,100
June	3,792	2,514	3,082	183,400
July	3,508	926	2,201	135,300
August	834	488	641	39,410
September	545	386	428	25,470
October	545	386	440	27,050
November	435	386	388	23,090
December	488	386	389	23,920
The year	4,076	386	1,250	906,400

ASOTIN CREEK 1¼ MILES ABOVE ASOTIN, WASH.

This station was established March 26, 1904, by W. W. Schlecht. It is located at the highway bridge about 1¼ miles above Asotin, Wash., at the power house of the Lewiston Water and Power Company. A plain staff gage, graduated to feet and tenths, is nailed vertically to the downstream face of the left abutment. It is read once each day by M. E. Turner. Discharge measurements are made from the side of the single-span bridge to which the gage is attached. The initial point for soundings is a 20-penny nail driven into the floor of the bridge above the mean edge of the left abutment, and marked zero. The channel is straight for about 120 feet above and 40 feet below the station, and the current is swift. Both banks are low and liable to overflow during extreme high water. They are both lined with brush, the left bank being covered with orchards and houses. The bed of the stream is composed of gravel and bowlders, free from vegetation, and fairly permanent. There is but one channel at low and two channels at high stages. At low water the current near the right bank may flow diagonally toward the center of the stream, at which times it is advisable to make the measurements from the upstream side of the bridge, while during high stages the water at the

upstream side is too swift and broken for accurate measurements. Bench mark No. 1 is a 20-penny nail driven horizontally into the guy pole for the chimney of the Lewiston Water and Power Company's power house between the power house and the bridge. It is marked "U. S. G. S. B. M." The elevation is 6.44 feet above the zero of the gage. Bench mark No. 2 is a 20-penny nail driven vertically into the stump of an old telegraph pole on the south side of the road about 100 feet from the bridge, marked "U. S. G. S. B. M." Its elevation is 7.57 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Asotin Creek 1¼ miles above Asotin, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
March 19	W. W. Schlecht	37	50	3.79	2.47	189
April 22	W. G. Steward	51	87	7.83	3.94	685
July 1	do	30	32	1.31	2.52	42
August 12	Hulburt and Moore	28	11	.39	2.10	5

Mean daily gage height, in feet, of Asotin Creek 1¼ miles above Asotin, Wash., for 1904.

Day.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov	Dec.
1		2.60	3.60	3.20	2.50	2.00	2.20	2.20	2.30	2.30
2		2.50	3.60	3.20	2.50	2.00	2.20	2.20	2.30	2.30
3		2.60	3.50	3.20	2.90	1.90	2.20	2.20	2.30	2.30
4		2.70	3.50	3.10	2.70	1.90	2.10	2.20	2.30	2.20
5		2.70	3.50	3.10	2.60	1.90	2.10	2.20	2.30	2.20
6		2.90	3.50	3.20	2.50	1.90	2.10	2.20	2.30	2.20
7		2.80	3.40	3.20	2.40	2.00	2.10	2.30	2.30	2.20
8		2.60	3.40	3.10	2.40	2.00	2.10	2.30	2.30	2.20
9		2.80	3.40	3.00	2.40	2.10	2.10	2.30	2.30	2.20
10		2.80	3.40	3.00	2.40	2.10	2.10	2.30	2.30	2.20
11		3.10	3.50	3.00	2.30	2.10	2.10	2.30	2.30	2.20
12		3.20	3.50	3.00	2.30	2.10	2.10	2.30	2.30	2.20
13		3.20	3.50	2.90	2.20	2.10	2.10	2.30	2.30	2.20
14		3.50	3.50	2.90	2.20	2.10	2.20	2.30	2.30	2.20
15		3.60	3.60	2.90	2.40	2.10	2.20	3.10	2.30	2.20
16			3.50	2.90	2.30	2.10	2.20	2.50	2.30	2.30
17		4.30	3.50	2.80	2.30	2.10	2.20	2.30	2.30	2.30
18		4.20	3.60	2.80	2.20	2.10	2.20	2.30	2.30	2.30
19		4.10	3.60	2.80	2.20	2.10	2.20	2.30	2.30	2.30
20		4.20	3.60	2.80	2.20	2.10	2.20	2.30	2.30	2.30
21		4.10	3.60	2.70	2.20	2.10	2.20	2.30	2.30	2.30
22		4.00	3.70	2.70	2.10	2.10	2.20	2.30	2.30	2.20
23		3.80	3.80	2.60	2.10	2.10	2.20	2.30	2.30	2.20
24		3.70	3.70	2.60	2.10	2.10	2.20	2.30	2.30	2.20
25		3.70	3.60	2.60	2.10	2.10	2.20	2.30	2.30	2.20
26		3.60	3.40	2.60	2.10	2.10	2.30	2.30	2.30	2.20

Mean daily gage height, in feet, of Asotin Creek 1¼ miles above Asotin, Wash., for 1904—Continued.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
27	2.10	3.80	3.30	2.50	2.00	2.10	2.30	2.30	2.30	2.20
28	2.20	3.90	3.30	2.50	2.00	2.10	2.20	2.30	2.30	2.20
29	2.70	3.80	3.20	2.50	2.00	2.30	2.20	2.30	2.30	2.30
30	2.75	3.70	3.10	2.50	2.00	2.20	2.20	2.30	2.30	2.60
31	2.50	.....	3.10	.....	2.00	2.20	.....	2.30	.....	2.40

ASOTIN CREEK AT SHELMAN'S RANCH, NEAR ASOTIN, WASH.

This station was established March 25, 1904, by W. W. Schlecht. It is located at Shelman's ranch, about 8 miles above Asotin, Wash. The station is 50 feet above the head-gate of Shelman's irrigation ditch. A plain staff gage, graduated to feet and tenths, is nailed to a tree on the left bank. It is read once each day by George Shelman. Discharge measurements are made by means of a cable, car, and tagged wire. The initial point for soundings is a nail driven into a hub below the cable support on the left bank. The tagged wire is marked every 5 feet. The channel is straight for about 100 feet above and below the station, and the current is swift. The right bank is a flood plain about 350 feet wide which may be flooded at extreme high water. The left bank is a similar plain about 120 feet wide which overflows during high water. Both banks are lined with trees and brush. The bed of the stream is composed of gravel and bowlders, free from vegetation, and fairly permanent. There is one channel at ordinary, and two at extreme high stages. The bench mark is the top of a 40-penny nail driven horizontally into a large willow tree about 40 feet west of Shelman's house, 2 feet north of the road, marked "U. S. G. S. B. M." Its elevation is 10.00 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Asotin Creek at Shelman's ranch, near Asotin, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
March 25	W. W. Schlecht	35	31	3.61	2.03	113
April 22	W. G. Steward	40	70	6.54	3.15	458
July 1	do	30	31	3.00	1.79	92
August 12	Hulburt and Moore	26	17	2.31	1.52	40

Mean daily gage height, in feet, of Asotin Creek at Shelman's ranch, near Asotin, Wash., for 1904.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	.....	2.32	2.60	2.60	1.78	1.56	1.56	1.65	1.55
2	.....	2.40	2.60	2.50	1.80	1.54	1.55	1.55	1.55
3	.....	2.50	2.50	2.55	1.92	1.54	1.65	1.55	1.55
4	.....	2.55	2.50	2.50	1.95	1.54	1.55	1.55	1.55
5	.....	2.72	2.50	2.45	1.90	1.54	1.54	1.55	1.55
6	.....	2.75	2.50	2.60	1.80	1.54	1.54	1.58	1.55
7	.....	2.65	2.40	2.50	1.79	1.54	1.53	1.58	1.55
8	.....	2.60	2.40	2.40	1.81	1.53	1.53	1.59	1.55
9	.....	2.68	2.40	2.35	1.75	1.53	1.53	1.59	1.55
10	.....	3.10	2.45	2.35	1.75	1.55	1.53	1.56	1.55
11	.....	3.45	2.50	2.20	1.70	1.55	1.53	1.56	1.55
12	.....	3.62	2.50	2.10	1.70	1.55	1.53	1.56	1.55
13	.....	3.80	2.50	2.05	1.64	1.55	1.53	1.56	1.55
14	.....	4.05	2.60	2.05	1.68	1.55	1.53	1.56	1.55
15	.....	4.30	2.60	2.05	1.72	1.55	1.53	1.79	1.55
16	.....	3.80	2.60	2.05	1.72	1.55	1.53	1.60	1.55
17	.....	3.35	2.60	2.05	1.70	1.55	1.53	1.60	1.55
18	.....	3.25	2.70	2.05	1.69	1.55	1.53	1.60	1.55
19	.....	3.25	2.70	2.05	1.66	1.55	1.53	1.60	1.55
20	.....	3.35	2.70	2.00	1.65	1.55	1.53	1.56	.....
21	2.25	3.35	2.70	1.95	1.65	1.55	1.53	1.56	.....
22	2.25	3.20	2.90	1.95	1.65	1.55	1.53	1.56	.....
23	2.20	2.95	3.00	1.90	1.61	1.55	1.66	1.56	.....
24	2.10	2.68	3.00	1.85	1.61	1.55	1.62	1.55	.....
25	2.05	2.60	2.75	1.82	1.60	1.54	1.60	1.55	.....
26	2.00	2.65	2.60	1.80	1.59	1.54	1.56	1.55	.....
27	1.95	2.90	2.50	1.80	1.59	1.55	1.58	1.55	.....
28	1.95	3.00	2.50	1.78	1.58	1.57	1.58	1.55	.....
29	2.15	2.90	2.50	1.78	1.58	1.60	1.55	1.55	.....
30	2.30	2.60	2.50	1.75	1.57	1.58	1.55	1.55	.....
31	2.30	.....	2.50	.....	1.57	1.56	.....	1.55	.....

PALOUSE RIVER AT ELBERTON, WASH.

This station was established May 6, 1904, by W. G. Steward. It is located at the highway bridge about one-half mile above the depot in the town of Elberton, Wash. A plain staff gage, graduated to feet and tenths, is nailed vertically to the south end of the face of the left abutment of the bridge. It is read once each day by W. B. Peoples. Discharge measurements are made for the west channel from the upstream side of the bridge. For the east channel, measurements are made from the downstream side of the bridge. Sounding points are painted on the guard rails. The initial point for the west channel is a point on the guard rail immediately above the face of the left abutment. The initial point for the east channel is the left end of the downstream hand rail. Both initial points are marked zero with nails and black paint. The west channel is straight for about 1,500 feet above and below the station. The current is swift. The east channel leaves the main or west channel about

150 feet above the station and makes a reverse curve striking the bridge at an angle of about 30°. The east channel is straight for 300 feet below and curved above the station. At high water the current is swift; at low water there is no flow in this channel. The right bank is high and not liable to overflow except in case of extreme high water, in which case the town would be flooded. The left bank is low, and overflows during high water along the roadway to the east of the east channel. The bed of the stream is composed of rock and gravel, free from vegetation, and shifting. All the water flows in the one channel at low and two channels at high stages. Bench mark No. 1 is a 20-penny nail in a large white post on the south side of the railroad track about one-fourth mile east of the depot. Its elevation is 2,198.05 feet above sea level, and 5.80 feet above the zero of the gage. Bench mark No. 2 is a square black paint mark on the southeast window sill of the hotel. Its elevation is 2,203.91 feet above sea level, and 11.66 feet above the zero of the gage. Bench mark No. 3 is the head of a rivet in the base of the bridge truss at the southwest corner of the bridge, painted "U. S. G. S." on the plate. Its elevation is 2,206.01 feet above sea level, and 13.76 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Palouse River at Elberton, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 6	W. G. Steward	110	247	2.68	3.35	664
May 18	do	76	180	2.15	2.58	384
June 22	do	52	52	1.23	1.55	64
July 15 [a]	do	49	49	1.07	1.44	53
August 30 [a]	do	14	8	.85	.88	7

[a] Made at different sections.

Mean daily gage height, in feet, of Palouse River at Elberton, Wash., for 1904.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		2.00	1.60	1.10	0.90	0.90	1.20	1.40
2		2.00	1.80	1.20	.90	1.00	1.30	1.40
3		2.30	1.90	1.00	1.00	1.00	1.30	1.10
4		2.40	1.60	1.00	1.00	.90	1.10	1.10
5		2.30	1.10	1.00	.90	.90	1.10	1.10
6	3.30	2.20	1.30	0.90	.90	1.00	1.10	1.20
7	[a] 3.30	2.30	1.20	1.10	1.00	1.00	1.20	1.20
8	[a] 3.20	2.60	1.50	1.00	1.00	1.10	1.20	1.20
9	[a] 3.20	2.30	1.20	1.00	1.10	1.10	1.10	1.20

[a] Interpolated.

Mean daily gage height, in feet, of Palouse River at Elberton, Wash., for 1904—Continued.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
10	[a] 3.10	2.20	1.10	1.00	1.10	1.00	1.00	1.20
11	[a] 3.00	2.20	1.40	.90	1.00	1.00	1.00	1.10
12	[a] 3.00	2.20	1.30	.90	1.00	1.10	1.00	1.10
13	2.90	2.00	1.30	.80	1.00	1.10	1.00	1.10
14	2.80	2.00	1.30	.80	.90	1.10	1.00	1.20
15	2.70	1.90	1.40	.80	.90	1.30	1.00	1.20
16	2.70	1.90	1.40	.90	.90	1.30	1.00	1.20
17	2.70	1.80	1.40	.80	.90	1.20	1.00	1.20
18	2.60	1.70	1.30	.80	.90	1.30	1.00	1.30
19	2.60	1.70	1.50	.80	.90	1.20	0.90	1.40
20	2.60	1.80	1.50	.80	.90	1.00	1.00	1.50
21	2.50	1.60	1.60	.80	.80	1.30	1.20	1.60
22	2.50	1.60	1.40	1.00	.90	1.20	1.00	1.60
23	2.40	1.60	1.20	1.00	1.00	1.20	1.00	1.60
24	2.40	1.60	1.20	.70	.90	1.40	1.70	1.70
25	2.30	1.60	1.20	.70	.90	1.30	1.80	1.70
26	2.30	1.60	1.10	.90	.90	1.00	1.70	1.80
27	2.20	1.50	1.00	.80	.90	1.00	1.00	1.70
28	2.10	1.40	1.00	.80	.90	1.00	1.50	1.70
29	2.00	1.50	1.20	1.00	.80	1.00	1.30	1.70
30	2.00	1.50	1.20	.90	.80	1.30	1.50	1.70
31	2.00	.....	1.10	.90	.....	1.30	.....	1.70

[a] Interpolated.

Rating table for Palouse River at Elberton, Wash., from May 6 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.70	2	1.60	76	2.50	353	3.30	649
.80	5	1.70	94	2.60	390	3.40	686
.90	9	1.80	115	2.70	427	3.50	723
1.00	14	1.90	140	2.80	464	3.60	760
1.10	21	2.00	169	2.90	501	3.70	797
1.20	29	2.10	205	3.00	538	3.80	834
1.30	38	2.20	242	3.10	575	3.90	871
1.40	49	2.30	279	3.20	612	4.00	908
1.50	62	2.40	316				

The above table is applicable only for open-channel conditions. It is based upon 5 discharge measurements made during 1904. It is well defined between gage heights 0.80 foot and 3.40 feet. The table has been extended beyond these limits. Above gage height 2.10 feet the rating curve is a tangent, the difference being 37 per tenth.

Estimated monthly discharge of Palouse River at Elberton, Wash., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
May 6–31 [a]	330	200	402	24,720
June	316	62	162	9,640
July	140	14	45.6	2,800
August	29	5	10.1	621
September	21	5	10.7	637
October	49	9	23.1	1,420
November	115	9	31.1	1,850
December	115	21	54.4	3,340
The period				45,030

[a] Discharge May 7–12 interpolated.

PALOUSE RIVER AT HOOPER, WASH.

The headwater tributaries of this river have their sources in western Idaho. After reaching Washington they unite to form Palouse River, which has a general southwesterly direction, flowing through a rolling country. Six miles below Hooper, Wash., the river bends suddenly southward and enters its canyon, through which it continues until its junction with Snake River. For some distance above Hooper the river consists of a succession of deep pools, from 10 to 15 feet in depth, connected by short riffles. Its valley is about one-half mile in width and bordered with basaltic cliffs approximately 300 feet in height. A short distance above the mouth of the river are the Palouse Falls, which are approximately 180 feet in height.

The measurements of Palouse River are of value in showing the amount of water that could be utilized for irrigation on the lands of Washtucna Valley and in the section north of Pasco.

The gaging station is located at Hooper, Wash. Gage No. 1 was established April 1, 1897, by the land department of the Northern Pacific Railroad. On September 9, 1897, C. C. Babb took charge of the station for the United States Geological Survey, and placed gage No. 2 a mile below the former location and opposite the water tank, and stretching a cable across the river for discharge measurements. The rod was inclined, fastened to posts driven into the right bank. The bench mark was a point of rock, marked with red paint, on a ledge on the left bank of the river opposite the gage and its elevation was 7.60 feet above datum. When the new gage read 2.1 feet the height on the Northern Pacific Railroad gage was 6.1 feet.

A wire gage, No. 3, was established about 20 feet above the cable by Sydney Arnold in 1903, the datum remaining the same as for gage No. 2. The gage was repaired and checked from the original bench mark August 26, 1903. At this time it was discovered that the observer was reporting readings 0.85 too low, and the daily gage readings were adjusted back to November 9, 1900, the most probable date of error. During the high spring floods of 1904, gage No. 3 was washed away and a new gage, No. 4, was established, the same datum being used as was used for gages Nos. 2 and 3. From 1.3 to 10 feet the rod is inclined, and from 10 to 14.2 feet it is vertical. This rod is firmly fastened to the bank, graduated to feet and tenths, and painted with white paint. Gage No. 4 is the one now in use. The gage is read once each day by Frank Hill, a rancher living near the station. Discharge measurements are made by means of a cable, car, tagged wire, and stay wire. The stay wire is located about 60 feet upstream from the cable. The initial point for soundings is the cable post on the left bank. The channel is straight for 200 feet above and for one-fourth of a mile below the cable. The current is swift. The left bank is high and can not overflow. The right bank overflows during high stages of the river. Both banks are covered with brush. The bed of the stream is rocky and free from vegetation. Bowlders in the bed of the stream make it difficult to obtain accurate results at this point at low water. There is but one channel at all stages. Bench mark No. 1 is the original bench mark established by C. C. Babb. It is the highest point on a ledge of rock on the left bank 200 feet below the cable, directly opposite the point at which the inclined gage was located. It is painted black. Its elevation is 7.60 feet above gage datum. Bench mark No. 2 is the top of a large rock on the right bank 250 feet west of the cable post and 115 feet from the water's edge. Its elevation is 10.88 feet above gage datum.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Palouse River at Hooper, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
January 15	C. B. Cox	92	305	2.34	4.00	715
January 16	do	97	352	2.97	4.65	1,043
January 19	do	95	332	2.60	4.32	862
January 21	do	88	258	2.00	3.43	496
February 26	G. H. Bliss	106	515	4.00	6.15	2,050
February 27	G. F. Harley	108	554	4.37	6.57	2,420
February 29	do	106	489	4.01	6.00	1,965
March 1	do	107	473	3.78	5.74	1,790
March 4	do	101	395	3.32	5.08	1,310
March 6	do	104	427	3.44	5.32	1,470
March 8	do	213	1,068	5.52	9.85	5,900
March 8	do	216	1,071	5.99	10.40	6,410
March 10	do	253	1,939	6.75	13.50	13,080
March 10	do	237	1,647	5.87	12.35	9,670
April 1	do	110	715	5.10	7.93	3,647
April 1	do	110	715	5.24	7.92	3,750
April 2	do	110	665	4.75	7.44	3,156
April 2	do	110	654	4.91	7.38	3,210
April 13	W. G. Steward	183	939	5.35	9.06	5,020
April 13	do	183	939	5.18	9.03	4,966
June 1	do	79	165	1.50	2.50	257
July 15	do	72	99	.86	1.48	86
August 4	do	54	36	1.00	1.10	36
August 30	do	39	22	.76	.80	17

Mean daily gage height, in feet, of Palouse River at Hooper, Wash., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.10	2.70	5.90	8.20	5.70	2.50	1.60	1.10	0.80	0.85	1.00	1.30
2	2.10	2.60	5.80	7.50	5.60	2.50	1.70	1.10	.80	.85	1.00	1.30
3	2.00	2.65	5.15	7.15	5.10	2.60	1.65	1.10	.80	.85	1.00	1.35
4	2.00	2.65	5.00	7.25	4.85	2.95	1.70	1.10	.80	.85	1.10	1.25
5	2.10	2.75	5.00	7.60	4.70	3.30	1.70	1.10	.80	.85	1.10	1.25
6	2.10	3.00	5.25	7.50	4.45	3.10	2.00	1.05	.80	.85	1.05	1.25
7	2.05	3.15	6.35	7.60	4.40	2.95	1.70	1.05	.80	.85	1.05	1.20
8	2.00	3.00	9.70	7.70	4.30	3.20	1.60	1.00	.80	.85	1.05	1.15
9	2.05	2.90	14.75	7.35	4.20	3.35	1.60	1.00	.75	.90	1.10	1.10
10	2.15	2.75	13.60	6.90	4.05	3.15	1.85	1.00	.75	.90	1.10	1.20
11	2.55	2.80	12.25	7.05	3.90	2.95	1.65	.95	.75	.90	1.05	1.20
12	2.25	3.20	10.80	7.60	3.95	2.80	1.55	.95	.75	.95	1.10	1.30
13	2.70	3.10	9.20	8.90	3.95	2.70	1.45	.95	.75	.95	1.10	1.30
14	3.60	3.10	8.40	9.25	3.90	2.55	1.40	.95	.75	.95	1.10	1.30
15	3.85	3.20	8.30	9.40	3.60	2.50	1.40	.95	.80	1.00	1.10	1.35

Mean daily gage height, in feet, of Palouse River at Hooper, Wash., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
16	4.70	3.85	8.45	9.60	3.55	2.40	1.50	.95	.80	1.00	1.10	1.45
17	4.40	4.10	8.25	9.90	3.50	2.30	1.45	.90	.80	1.00	1.10	1.45
18	4.60	4.70	7.95	10.30	3.45	2.20	1.45	.90	.80	1.00	1.05	1.45
19	4.35	4.55	8.30	8.30	3.40	2.15	1.45	.90	.80	1.10	1.05	1.45
20	3.85	4.55	8.40	7.25	3.35	2.10	1.35	.85	.80	1.05	1.10	1.45
21	3.50	4.30	8.30	7.15	3.35	2.05	1.35	.85	.85	1.10	1.15	1.45
22	3.30	4.25	8.85	7.10	3.30	2.00	1.35	.85	.85	1.10	1.15	1.75
23	3.30	4.50	7.90	7.00	3.20	2.00	1.35	.85	.85	1.10	1.20	1.55
24	3.40	6.00	7.55	6.70	3.10	1.90	1.25	.85	.85	1.10	1.20	1.55
25	3.25	5.95	6.90	6.30	3.00	1.90	1.25	.85	.85	1.05	1.30	1.40
26	3.05	6.20	6.85	5.70	2.90	1.85	1.20	.80	.85	1.10	1.20	1.35
27	2.90	6.35	6.35	5.35	2.90	1.80	1.20	.80	.85	1.10	1.25	1.45
28	2.85	6.60	6.25	5.20	2.80	1.80	1.15	.80	.85	1.10	1.35	1.40
29	2.90	6.30	6.65	5.45	2.70	1.90	1.15	.80	.85	1.10	1.40	1.20
30	2.85	.....	6.95	5.70	2.55	1.75	1.15	.80	.85	1.10	1.30	1.30
31	2.80	.....	8.80	.....	2.50	.....	1.15	.80	.....	1.05	.....	1.35

Rating table for Palouse River at Hooper, Wash., from January 1, 1903, to December 31 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.60	10	2.30	215	4.00	715	7.50	3,270
.70	13	2.40	236	4.20	805	8.00	3,780
.80	17	2.50	259	4.40	900	8.50	4,330
.90	22	2.60	283	4.60	1,015	9.00	4,880
1.00	28	2.70	307	4.80	1,135	9.50	5,470
1.10	36	2.80	331	5.00	1,265	10.00	6,080
1.20	46	2.90	355	5.20	1,400	10.50	6,750
1.30	57	3.00	380	5.40	1,540	11.00	7,550
1.40	69	3.10	405	5.60	1,680	11.50	8,500
1.50	82	3.20	430	5.80	1,820	12.00	9,530
1.60	96	3.30	457	6.00	1,965	12.50	10,650
1.70	110	3.40	486	6.20	2,120	13.00	11,880
1.80	125	3.50	517	6.40	2,280	13.50	13,180
1.90	141	3.60	551	6.60	2,440	14.00	14,480
2.00	158	3.70	588	6.80	2,620	15.00	17,080
2.10	176	3.80	628	7.00	2,800	16.00	19,680
2.20	195	3.90	670				

The above table is applicable only for open-channel conditions. It is based upon 34 discharge measurements made during 1903 and 1904. It is well defined between gage heights 0.80 foot and 13.50 feet. The table has been extended beyond these limits. Above gage height 12.90 feet the rating curve is a tangent, the difference being 260 per tenth.

Estimated monthly discharge of Palouse River at Hooper, Wash., for 1904.

[Drainage area, 2,210 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	1,075	158	409	25,150	0.185	0.213
February	2,440	283	873	50,220	.395	.426
March	16,430	1,265	4,305	264,700	1.95	2.25
April	6,470	1,400	3,351	199,400	1.52	1.70
May	1,750	259	678	41,690	.307	.354
June	471	117	258	15,350	.117	.130
July	158	41	78.8	4,845	.036	.042
August	36	17	24.5	1,506	.011	.013
September	19	15	17.3	1,029	.0078	.0087
October	36	19	27.8	1,709	.013	.015
November	69	28	39.6	2,356	.018	.020
December	117	36	63.0	3,874	.029	.033
The year	16,430	15	844	611,800	.382	5.20

ROCK CREEK NEAR ST. JOHN, WASH.

This station was established October 15, 1903, by G. H. Bliss. It is located at the highway bridge which crosses Rock Creek at the outlet of Rock Lake, three-fourths of a mile from the ranch of the observer, C. K. Reimer. It is 9 miles northeast of St. John, Whitman County, Wash. The gage is a vertical rod fastened to the fifth pile bent of the southeast or left-bank approach. At high stages discharge measurements are made from the downstream side of the highway bridge, to which the gage is attached. At low stages they are made by wading below the bridge. The bridge is supported by pile bents and has a total span of 210 feet. The initial point for soundings is the end post of the downstream hand rail. The channel is straight for 200 feet above and for 75 feet below the station. The current is sluggish at the bridge at low stages. Both banks are low and rocky and liable to overflow at flood stages. The bed of the stream is covered with rocks and gravel and is liable to shift at flood stages. Bench mark No. 1 is a spike driven into the downstream side of the top of the sill of the third pile bent from the southeast or left-bank approach. Its elevation is 12.52 feet above the zero of the gage. Bench mark No. 2 is the top of a large rock on a point of rocks on the southeast side of the lake about 3,000 feet above the outlet. Its elevation is 16.70 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Rock Creek near St. John, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
January 29	G. H. Bliss	70	38	2.98	11.99	112
February 29 [a]	do	102	159	3.16	13.84	502
March 11	do	181	833	1.86	14.95	1,549
March 13	do	179	784	1.52	14.40	1,190
April 5	W. G. Steward	177	478	1.04	13.20	502
May 17	do	64	39	2.59	11.55	100
June 24	do	46	30	1.24	10.96	37
August 29	T. A. Noble	3	0.9	0.57	10.20	0.5

[a] From boat 2 miles below station.

Mean daily gage height, in feet, of Rock Creek near St. John, Wash., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	11.00	11.90	13.80	13.60	12.10	11.20	10.80	10.50	10.15	10.00	10.05	10.10
2	11.00	11.90	13.75	13.50	12.05	11.20	10.80	10.50	10.15	10.00	10.05	10.10
3	11.00	11.90	13.60	13.40	12.00	11.25	10.80	10.50	10.15	10.00	10.05	10.10
4	11.00	11.90	13.60	13.30	12.00	11.25	10.80	10.45	10.15	10.00	10.05	10.10
5	11.00	11.90	13.50	13.20	11.95	11.25	10.80	10.45	10.15	10.00	10.05	10.10
6	11.00	11.90	13.55	13.10	11.95	11.25	10.80	10.40	10.15	10.00	10.05	10.10
7	11.00	11.90	14.00	13.10	11.90	11.25	10.80	10.40	10.15	10.00	10.05	10.15
8	11.00	11.90	15.20	13.05	11.90	11.25	10.80	10.40	10.10	10.00	10.05	10.15
9	11.00	11.90	15.60	12.95	11.85	11.25	10.80	10.40	10.10	10.00	10.05	10.15
10	11.05	11.90	15.40	12.85	11.85	11.20	10.80	10.40	10.10	10.05	10.05	10.20
11	11.05	11.90	15.00	12.80	11.80	11.20	10.80	10.40	10.10	10.05	10.05	10.20
12	11.10	11.90	14.70	12.75	11.75	11.20	10.80	10.40	10.10	10.00	10.05	10.20
13	11.15	11.90	14.60	12.70	11.70	11.15	10.80	10.40	10.10	10.00	10.05	10.20
14	11.25	11.90	14.45	12.65	11.65	11.10	10.75	10.40	10.10	10.00	10.05	10.20
15	11.40	11.95	14.25	12.60	11.60	11.10	10.75	10.40	10.10	10.00	10.05	10.20
16	11.60	12.00	14.10	12.50	11.60	11.10	10.70	10.40	10.10	10.00	10.05	10.25
17	11.80	12.10	14.00	12.55	11.55	11.10	10.70	10.35	10.05	10.00	10.05	10.30
18	11.95	12.20	13.85	12.60	11.50	11.10	10.65	10.35	10.05	10.00	10.05	10.30
19	12.10	12.30	13.85	12.55	11.50	11.10	10.65	10.35	10.05	10.00	10.05	10.30
20	12.15	12.45	13.90	12.50	11.50	11.10	10.60	10.30	10.05	10.00	10.05	10.30
21	12.15	12.50	13.90	12.50	11.45	11.05	10.60	10.30	10.05	10.00	10.05	10.35
22	12.10	12.55	13.90	12.45	11.40	11.00	10.60	10.30	10.05	10.00	10.05	10.35
23	12.10	12.60	13.80	12.40	11.40	11.00	10.60	10.30	10.00	10.00	10.05	10.40
24	12.10	12.85	13.75	12.35	11.40	11.00	10.60	10.30	10.00	10.00	10.05	10.40
25	12.10	13.10	13.70	12.30	11.35	10.95	10.60	10.25	10.00	10.05	10.05	10.40
26	12.05	13.30	13.60	12.30	11.35	10.95	10.55	10.25	10.00	10.05	10.05	10.40
27	12.00	13.50	13.50	12.25	11.30	10.90	10.55	10.20	10.00	10.05	10.05	10.40
28	12.00	13.80	13.40	12.20	11.30	10.85	10.55	10.20	10.00	10.05	10.05	10.40
29	12.00	13.80	13.35	12.10	11.30	10.85	10.55	10.20	10.00	10.05	10.10	10.45
30	11.95	.....	13.50	12.10	11.30	10.85	10.50	10.20	10.00	10.05	10.10	10.50
31	11.90	.....	13.60	.....	11.25	.....	10.50	10.20	.....	10.05	.....	10.50

Rating table for Rock Creek near St. John, Wash., from October 15, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
10.00	0	11.20	59	12.40	245	13.50	650
10.10	.5	11.30	70	12.50	267	13.60	705
10.20	1.5	11.40	82	12.60	292	13.70	760
10.30	3	11.50	94	12.70	320	13.80	820
10.40	6	11.60	107	12.80	350	13.90	880
10.50	10	11.70	120	12.90	383	14.00	940
10.60	14	11.80	134	13.00	420	14.20	1,070
10.70	19	11.90	149	13.10	460	14.40	1,200
10.80	25	12.00	165	13.20	505	14.60	1,330
10.90	32	12.10	183	13.30	550	14.80	1,460
11.00	40	12.20	203	13.40	600	15.00	1,590
11.10	49	12.30	223				

The above table is applicable only for open-channel conditions. It is based upon 7 discharge measurements made during 1903 and 1904. It is well defined between gage heights 10.20 feet and 15.00 feet. The table has been extended beyond these limits. Above gage height 14.00 feet the rating curve is a tangent, the difference being 65 per tenth.

Estimated monthly discharge of Rock Creek, near St. John, Wash., for 1903 and 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
1903.				
October 15–31	1.5	0.3	0.48	16
November	8	.4	3.66	218
December	38.0	8	20.0	1,230
1904.				
January	193	40	109	6,702
February	820	149	268	15,420
March	1,980	575	969	59,580
April	705	183	345	20,530
May	183	64	113	6,948
June	64	28	49.7	2,957
July	25	10	19.1	1,174
August	10	1.5	4.9	301
September	1	0	.42	25
October	.2	0	.06	3.7
November	.5	.2	.22	13
December	10	.5	3.3	203
The year	1,980	0	157	113,900

COW CREEK NEAR KEYSTONE, WASH.

This station was established November 10, 1904, by Calvin Casteel. It is located at the highway bridge on the Sprague-Ritzville road crossing of Cow Creek, 2¼ miles east of Keystone, Wash., and one-fourth mile southeast of Lakeview schoolhouse. The station is a short distance below the foot of Colville Lake. A plain staff gage is nailed vertically to a post of the bridge at the upper left end. It is read once each day by S. A. Fulquartz. Discharge measurements are made from the upstream side of the single-span bridge, to which the gage is attached. The bridge is 18.6 feet long between abutments. The initial point for soundings is a nail driven into the end of a plank on the deck of the bridge above the edge of the abutment. The channel is straight for about 200 feet above and 100 feet below the station. The current above the station is moderate at ordinary and sluggish at low stages; below the station it is swift at all stages. Both banks are high, clean, and not liable to overflow. The bed of the stream is composed of rock and gravel, and is permanent. There is but one channel at all stages. The bench mark is a United States Geological Survey standard aluminum tablet set in a large bowlder, 125 feet up Cow Creek from Sprague-Ritzville road crossing, on the right bank. The bench mark is marked 1883. Its elevation is 1,883.150 feet above sea level and 4.19 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Cow Creek near Keystone, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
November 8	C. Casteel	7	4	0.58	0.61	3
November 8	do	7	4.5	.58	.61	2.6

Mean daily gage height, in feet, of Cow Creek near Keystone, Wash., for 1904.

Day.	Nov.	Dec.	Day.	Nov.	Dec.	Day.	Nov.	Dec.
1		0.72	12		0.77	22	0.68	0.82
2		.72	13	0.62	.78	23	.70	.81
3		.71	14	.48	.80	24	.71	.80
4		.70	15	.65	.77	25	.72	.87
5		.71	16	.63	.78	26	.73	.82
6		.71	17	.63	.78	27	.73	.83
7		.72	18	.61	.82	28	.74	.81
8		.73	19	.65	.82	29	.75	.83
9		.74	20	.65	.83	30	.74	.85
10	0.61	.75	21	.67	.82	31		.87
11	.62	.76						

COW CREEK AT HOOPER, WASH.

This station was established February 26, 1904, by G. H. Bliss. It is located one-half mile east of Hooper, Wash., about a half mile above the point where the creek empties into Palouse River. A plain vertical staff gage graduated to feet and tenths is driven into the bed of the stream and braced to a stake on the left bank. The gage is read only at the time of making meter measurements. Discharge measurements are made by wading at the gage. The initial point for soundings is a nail driven into the top of the stake, to which the gage is braced. The channel is straight for about 50 feet above and 25 feet below the station. The current is fairly swift at flood stages. Both banks are high and clean. The right bank may overflow during flood stages. The bed of the stream is composed of clean sand, and is permanent. There is but one channel at all stages. Bench mark No. 1 is the top of the nail, which serves as the initial point for soundings. Its elevation is 7.68 feet above the zero of the gage. Bench mark No. 2 is a mark on a large rock 100 feet south and a little to the west of the gage. A piece has been broken from the east face of the rock, and it is marked "B. M." The elevation of this bench mark is 8.56 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurements of Cow Creek at Hooper, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
February 26	G. H. Bliss	25	22	1.41	4.80	32
March 7	Geo. F. Harley	25	22	1.78	4.82	46
August 5	W. G. Steward	3	1	.85	4.32	1
August 31 [a]	do	12	10	.44	4.46	4

[a] 75 feet above gage.

WALLA WALLA RIVER (SOUTH FORK) NEAR MILTON, OREG.

This station was originally established February 15, 1903, 6 miles above the mouth of the river and 12 miles from Milton, Oreg. The gage was read once each day from the date of establishment to October 31, 1903, by N. Redden. As there were no means for making flood measurements at this point, the station was moved to the highway bridge one-fourth mile above the junction of the North and South forks, 6 miles from Milton. The gage is a vertical 1¼ by 9 inch timber, secured to a stump on the right bank three-fourths mile above the highway bridge and directly back of the house of the observer,

Harry Huber, who reads the gage once each day. Discharge measurements are made from the upstream side of the single-span highway bridge one-fourth mile above the mouth of the South Fork. The initial point for soundings is the south side of a projecting beam which supports the north end of the lower chord of the bridge. The bridge has a span of 65 feet between abutments. The channel is straight for 100 feet above, and for 150 feet below the bridge. The current is swift. The right bank is low, wooded, and liable to overflow. The left bank is low, but is not liable to overflow, and is without trees. The bed of the stream is composed of gravel, free from vegetation, and not liable to shift to any considerable extent. Bench mark No. 1 is a 20-penny nail driven into a cottonwood tree 1 foot in diameter 15 feet above the gage rod. Its elevation is 7.00 feet above the zero of the gage. Bench mark No. 2 is a 20-penny nail driven into the tree to which the gage is attached. Its elevation is 7.00 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurements of Walla Walla River (South Fork) near Milton, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
April 15	Yates and Saxton	60	136	5.70	2.70	955
May 14[a]	Murphy and Sawyer	49	74	6.80	2.18	505
August 12	W. C. Sawyer	32	33	3.50	1.51	118
October 20	do	35	32	3.59	1.52	113

[a] 6 miles above railroad station.

Mean daily gage height, in feet, of Walla Walla River (South Fork) near Milton, Oreg., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.75	1.70	1.90	1.85	.....	2.00	1.60	1.55	.....	.....	1.50	1.50
2	1.75	1.70	1.95	1.75	2.10	1.90	1.60	.....	.....	.....	1.50	1.50
3	1.75	1.70	1.90	1.85	2.20	1.90	1.60	.....	.....	1.50	1.50	1.50
4	1.75	1.70	1.90	.....	2.10	1.90	.....	1.55	.....	1.50	1.50	1.50
5	1.70	1.70	1.90	1.75	2.00	.....	1.65	.....	.....	1.50	1.50	1.50
6	1.70	1.70	2.00	1.95	2.05	1.95	1.60	.....	1.50	1.50	1.50	1.50
7	1.70	.....	2.40	1.85	2.10	1.85	1.60	.....	.....	1.55	1.50	1.50
8	1.70	1.70	2.70	1.80	2.00	1.80	1.65	.....	1.50	.....	1.50	1.55
9	1.75	1.70	2.45	1.85	2.00	1.75	1.60	1.55	.....	1.55	1.50	1.55
10	1.80	1.70	2.10	.....	2.20	1.75	.....	.....	.....	1.50	1.50	1.55
11	1.80	.....	1.90	2.40	2.15	1.70	1.60	.....	.....	1.50	1.50	1.55
12	1.80	1.70	1.80	2.65	2.20	1.70	1.60	1.51	.....	1.60	1.50	1.55
13	1.90	1.75	1.80	2.90	2.20	1.65	1.55	.....	.....	1.55	1.50	1.55
14	2.00	1.70	1.70	3.40	2.15	1.65	1.55	1.50	.....	1.55	1.55	1.60
15	2.10	1.85	1.80	3.20	.....	1.65	1.60	.....	.....	1.60	1.55	1.60
16	2.00	2.10	1.75	2.50	2.10	1.65	1.60	.....	1.50	1.55	1.55	1.60
17	2.00	2.00	1.70	.....	2.10	1.65	1.65	.....	1.50	1.55	1.55	1.60
18	1.95	1.95	1.75	2.30	.....	1.65	1.65	.....	1.50	1.55	1.55	1.60
19	1.80	1.90	1.70	2.50	.....	1.60	1.65	.....	.....	1.60	.....	1.60
20	1.85	1.85	1.80	2.50	2.15	1.60	1.60	.....	.....	1.55	1.55	1.60
21	1.85	1.80	1.75	2.35	2.20	1.60	1.60	1.50	1.50	1.55	1.55	1.60

Mean daily gage height, in feet, of Walla Walla River (South Fork) near Milton, Oreg., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
22	1.80	2.00	1.70	2.20	2.20	.....	1.60	.....	.....	1.55	1.55	1.60
23	1.85	2.05	1.60	2.10	2.25	1.55	1.60	.....	1.50	1.50	1.60	1.55
24	.....	2.00	1.50	2.00	2.10	1.50	1.60	.....	.....	1.50	.....	1.60
25	1.85	2.00	1.50	2.00	2.00	.....	.....	.....	1.50	1.50	1.60	1.60
26	1.80	2.00	1.45	2.05	1.95	1.55	1.55	.....	.....	1.50	1.60	1.60
27	1.75	2.05	1.45	2.20	1.90	1.60	1.55	.....	.....	1.50	1.60	1.60
28	.....	2.00	1.50	2.25	1.90	1.60	1.55	1.50	1.50	1.50	1.60	1.60
29	1.75	2.00	1.85	2.20	.....	1.60	1.55	.....	1.50	.....	1.50	1.60
30	.....	.....	2.00	2.10	1.90	1.60	1.55	.....	1.50	1.50	1.50	1.78
31	1.70	.....	1.80	.....	.....	.....	1.55	.....	.....	1.50	.....	1.75

Rating table for Walla Walla River (South Fork) near Milton, Oreg., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.40	71	2.00	374	2.50	765	3.00	1,255
1.50	109	2.10	443	2.60	858	3.10	1,355
1.60	152	2.20	516	2.70	955	3.20	1,455
1.70	200	2.30	595	2.80	1,055	3.30	1,555
1.80	253	2.40	678	2.90	1,155	3.40	1,655
1.90	310						

The above table is applicable only for open-channel conditions. It is based upon 4 discharge measurements made during 1904. It is well defined between gage heights 1.50 feet and 2.70 feet. The table has been extended beyond these limits. Above gage height 2.70 feet the rating curve is a tangent, the difference being 100 per tenth.

Estimated monthly discharge of Walla Walla River (South Fork) near Milton, Oreg., for 1904.

Month.	Discharge in second-feet.[a]			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January	443	200	264	16,230
February	443	200	282	16,220
March	955	90	294	18,080
April	1,655	226	569	33,860
May	555	310	433	26,620
June	374	109	203	12,080
July	175	130	149	9,162
August	130	109	117	7,194
September	109	109	109	6,486
October	152	109	121	7,440
November	152	109	124	7,379
December	242	109	143	8,793
The year	1,655	90	234	169,500

[a] Discharge interpolated for missing gage heights.

WALLA WALLA RIVER AT MILTON, OREG.

This station was established February 14, 1903, by T. A. Noble. The gage is a vertical rod on the left bank one-half mile above the county bridge and just above the head-gate of an irrigation ditch. The gage is read once each day by S. L. Smith. During 1903 discharge measurements were made from a cable just above the gage. Measurements made at this point include the discharge of the irrigation ditch just below the gage. On October 29, 1903, a stay wire was installed about 35 feet above the county bridge, to be used in making flood measurements. At the close of the season of 1903 the cable was abandoned, and discharge measurements have since been made from the highway bridge. Measurements made at this point do not include the discharge of the irrigation ditch just below the gage. This ditch has to be measured separately, but is included in the estimate given below. There is another irrigation ditch taken out on the left bank just below the bridge, which is included in the measurements made at the bridge. The gage heights have been adjusted to obviate the effect of changes in a diversion dam below the gage. The initial point for soundings is the end of the lower chord on the upstream side of the bridge at the right bank. The bridge has a single span of 75 feet between abutments. The channel is straight for 80 feet above and for 150 feet below the station. The current is swift. Both banks are low, wooded, but not liable to overflow. There is but one channel at all stages. The bed of the stream is composed of gravel, free from vegetation, and liable to shift. The bench mark is the top of a sharp projecting rock 4 feet from the gage and 3 feet from the tree to which the gage is attached. Its elevation is 4.37 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurements of Walla Walla River at Milton, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
April 16	H. A. Yates	66	186	7.46	2.5	1,387
May 14	Murphy and Sawyer	64	107	6.70	1.93	715
June 13	W. C. Sawyer	46	64	3.55	1.37	267
August 12	do	44	40	2.42	1.01	139
October 20	do		43	3.37	1.05	145

Mean daily gage height, in feet, of Walla Walla River at Milton, Oreg., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.04	0.96	1.33	1.91	1.80	1.58	1.13	1.01	1.03	1.01	1.08	1.17
2	1.04	.96	1.36	1.90	1.72	1.68	1.12	1.01	1.03	1.00	1.09	1.17
3	1.04	.96	1.28	1.93	1.81	1.68	1.11	1.01	1.02	.98	1.09	1.17
4	1.03	.95	1.33	1.95	1.92	1.67	1.20	1.00	1.02	.99	1.10	1.19
5	1.02	.95	1.30	1.88	1.88	1.65	1.20	1.00	1.01	1.00	1.10	1.18
6	1.00	.96	1.47	2.10	1.86	1.63	1.18	1.00	1.00	1.00	1.10	1.16
7	1.02	.95	1.85	1.95	1.81	1.65	1.22	1.01	1.00	1.02	1.10	1.18
8	1.03	.95	3.20	1.90	1.78	1.58	1.20	1.01	1.00	1.02	1.10	1.19
9	1.02	.95	2.66	1.95	1.74	1.53	1.17	1.01	1.00	1.01	1.11	1.16
10	1.10	.92	2.20	2.31	1.98	1.50	1.16	1.00	1.00	1.01	1.13	1.14
11	1.07	.92	2.02	2.60	2.00	1.47	1.14	1.01	.99	1.06	1.12	1.16
12	1.22	1.01	1.90	2.92	1.96	1.43	1.13	1.01	.99	1.11	1.14	1.17
13	1.50	.99	1.75	2.93	1.97	1.38	1.12	1.00	.98	1.06	1.14	1.16
14	1.45	.97	1.73	3.20	1.98	1.37	1.11	1.00	.97	1.04	1.15	1.20
15	1.43	1.03	1.85	3.00	1.95	1.35	1.15	1.00	.94	1.10	1.16	1.19
16	1.38	1.45	1.80	2.51	1.90	1.34	1.20	1.01	.94	1.09	1.17	1.18
17	1.36	1.43	1.74	2.43	1.90	1.36	1.14	1.01	.94	1.07	1.18	1.17
18	1.33	1.30	1.70	2.31	1.92	1.36	1.12	1.00	.94	1.06	1.19	1.19
19	1.30	1.20	1.74	2.45	2.01	1.35	1.11	1.01	.94	1.05	1.19	1.20
20	1.16	1.22	1.84	2.55	2.02	1.35	1.10	1.02	.93	1.05	1.22	1.20
21	1.15	1.15	1.76	2.33	2.03	1.34	1.09	1.00	.93	1.06	1.22	1.21
22	1.21	1.45	1.72	2.21	2.02	1.32	1.08	1.00	.93	1.06	1.21	1.20
23	1.19	1.47	1.69	2.08	2.02	1.25	1.07	1.01	1.04	1.06	1.19	1.19
24	1.15	1.44	1.65	2.01	2.01	1.22	1.07	1.00	1.04	1.07	1.18	1.19
25	1.13	1.37	1.54	1.92	1.84	1.20	1.05	1.00	1.00	1.06	1.18	1.18
26	1.10	1.40	1.50	2.05	1.78	1.18	1.04	1.01	1.05	1.05	1.17	1.18
27	1.07	1.45	1.47	2.11	1.72	1.16	1.03	1.00	1.01	1.05	1.16	1.17
28	1.04	1.40	1.54	2.18	1.67	1.17	1.03	1.01	1.00	1.04	1.15	1.17
29	1.02	1.36	1.95	2.08	1.62	1.16	1.02	1.01	1.00	1.04	1.16	1.22
30	1.00	.....	2.21	2.18	1.61	1.14	1.02	1.02	1.00	1.07	1.17	1.40
31	.98	.....	1.98	.....	1.60	.....	1.01	1.02	.....	1.07	.....	1.42

Rating table for Walla Walla River at Milton, Oreg., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.90	120	1.50	339	2.10	913	2.70	1,625
1.00	135	1.60	408	2.20	1,031	2.80	1,744
1.10	159	1.70	488	2.30	1,149	2.90	1,863
1.20	192	1.80	577	2.40	1,268	3.00	1,982
1.30	233	1.90	679	2.50	1,387	3.10	2,101
1.40	281	2.00	795	2.60	1,506	3.20	2,220

The above table is applicable only for open-channel conditions. It is based upon 4 discharge measurements made during 1904, and is fairly well defined.

Estimated monthly discharge of Walla Walla River at Milton, Oreg., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January	339	131	183	11,250
February	321	122	195	11,220
March	2,220	225	606	37,260
April	2,220	658	1,105	65,750
May	830	408	654	40,210
June	472	171	297	17,670
July	200	137	165	10,140
August	139	135	136	8,362
September	146	124	134	7,974
October	162	131	145	8,916
November	200	154	175	10,410
December	292	171	192	11,810
The year	2,220	122	332	241,000

UMATILLA RIVER AT GIBBON, OREG.

This station was established by C. C. Babb July 22, 1896. The original gage rod was located one-fourth mile below the railroad station. The gage, together with the cable from which discharge measurements were made, was carried away by a flood in May, 1902. The bench mark, consisting of a cross on the highest point of the rock to which the original gage was fastened, has also been destroyed. On September 10, 1902, the station was reequipped with a wire gage, cable, and car. The cable is located in its original position. To secure a better location for the gage the new wire gage was established a few hundred feet nearer the cable. It was located on a beam projecting over the water and spiked to the top of the cribwork on the left bank about 10 feet north of the railroad track. The wire gage was repaired July 29, 1903, but no change was made in the datum. The length of the wire from the marker to the bottom of the eye in the center of the web of the section of the rail, used as a weight, was 16.30 feet. Bench mark No. 1 is the head of a 40-penny spike driven flush with the surface of the crib timber opposite the 1-foot mark of the gage scale. Its elevation is 8.66 feet above gage datum. Bench mark No. 2 is a 40-penny spike in a telegraph pole directly across the railroad track from the gage and 30 feet distant. Its elevation is 10.35 feet above gage datum.

The flood in March and April, 1904, changed the channel at the gage to such an extent that the gage was rendered useless. A vertical staff gage, graduated to feet and tenths, was bolted and braced,

on October 15, 1904, to a point of rocks in a pool where the bed is least liable to shift, on the north side of the river, about one-half mile below the railroad station at Bingham Springs and one-half mile above the cable from which discharge measurements are made. The bench mark for this gage is a square chisel draft, and the letters "B. M." cut in the rock about 15 feet from the gage, 10 feet downstream. Its elevation is 5.17 feet above the zero of the gage. No relation has been established between this and previous gages. During 1904 the gage was read once each day by Walter Swart. The initial point for soundings is the face of the tree to which the cable is attached, on the right bank. The channel is straight for 100 feet above and below the cable. The right bank is high. The left bank is rather low, and has a slough during high water. The bed of the stream is composed of gravel and is somewhat shifting.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurements of Umatilla River at Gibbon, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
March 19	J. H. Lewis	120	188	6.3	1.85	1,180
April 14	Brainard and Saxton	144	683	8.34	5.63	5,715
April 25	W. C. Sawyer	111	234	6.79	1.00	1,591
October 14	do		35	2.80	[a] 1.17	98

[a] New gage.

Mean daily gage height, in feet, of Umatilla River at Gibbon, Oreg., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.00	1.30	1.70	2.00	0.80						1.20	1.30
2	1.00	1.30	1.60	2.25	.70						1.20	1.20
3	1.00	1.30	1.60	2.70	.90						1.20	1.20
4	1.00	1.25	1.50	2.50	.90						1.20	1.20
5	1.00	1.25		2.30	.80						1.20	1.20
6	1.00	1.25	2.20	3.20	.70						1.20	1.20
7	1.00	1.20	3.35	2.60	.70						1.10	1.20
8	1.00	1.20	4.75	2.60	.70						1.10	1.20
9	1.10	1.20	3.60	3.00	.70						1.10	1.20
10	1.20	1.20	2.85	4.00	.70						1.10	1.20
11	1.20	1.20	2.40	4.40	.70						1.10	1.20
12	1.40	1.20	2.00	4.60	.70						1.10	1.20
13	1.80	1.20	1.70	5.20	.70						1.10	1.20
14	1.90	1.20	1.80	5.35	.60						1.10	1.30
15	2.10	1.30	1.80	4.80	.60					1.17	1.20	1.30
16	2.00	1.90	1.70	4.00	.60						1.20	1.30
17	1.90	1.80	1.60	3.50	.50					1.22	1.20	1.30
18	1.80	1.70	1.80	3.20	.50						1.20	1.30
19	1.50	1.60	1.80	3.50	.60					1.20	1.20	
20	1.40	1.90	1.90	2.70	.70					1.20	1.20	1.30

Mean daily gage height, in feet of Umatilla River at Gibbon, Oreg., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec
21	1.40	1.70	1.75	.....	.60	.....	.....	.....	.....	1.15	1.20	1.30
22	1.90	1.60	1.50	1.70	.50	.....	.....	.....	.....	1.10	1.20	1.30
23	2.00	2.10	1.40	1.10	.40	.....	.....	.....	.....	1.10	1.20	1.30
24	1.90	2.10	1.10	.90	.30	.....	.....	.....	.....	1.20	1.20	1.30
25	1.80	2.00	1.00	1.00	.10	.....	.....	.....	.....	1.20	1.20	.....
26	1.60	2.00	1.00	.....	.00	.....	.....	.....	.....	1.20	1.20	1.30
27	1.50	1.90	1.00	1.50	.....	.....	.....	.....	.....	1.20	1.20	1.30
28	1.40	1.80	1.10	1.50	.....	.....	.....	.....	.....	1.20	1.30	1.40
29	1.50	1.80	2.10	1.20	.....	.....	.....	.....	.....	1.20	1.30	1.40
30	1.30	.....	2.60	1.00	.....	.....	.....	.....	.....	1.20	1.30	1.50
31	1.30	.....	2.20	.....	.....	.....	.....	.....	.....	1.20	.....	1.70

NOTE.—Gage heights October 15 to December 31 referred to new gage.

UMATILLA RIVER AT PENDLETON, OREG.

This station was established May 22, 1903, by F. W. Huber. It is located at the Main Street Bridge at Pendleton, Oreg. A short distance above the bridge at which the gage is located water is taken out of the river by the Farmers Mill ditch. This ditch carries from 30 to 50 second-feet, and at low stages the entire river is diverted into this ditch. The water is returned to the river at a point about 4,000 feet below the Main Street Bridge and about 1,500 feet above the railroad bridge, at which discharge measurements are made. The original river gage was a vertical 1 by 5 inch board, 10 feet long, spiked to the middle of the left or south side of the center pier of the Main Street Bridge. On July 18, 1903, this gage was replaced by a 2 by 6 inch board, 10 feet long, fastened in the same position as the original gage and on the same datum. During 1904 the gage has been read by the Geological Survey office at Pendleton. Discharge measurements are made from the Oregon Railroad and Navigation Company's bridge, about 1 mile downstream from the gage. The initial point for soundings is the face of the crib abutment on the left bank. The railroad bridge consists of a single span of 145 feet, there being 116 feet of trestle approach on the right bank and an approach of 34 feet on the left bank. The channel is straight for 250 feet above and 200 feet below the railroad bridge. The current is swift at this point, but has a lower velocity than at the bridge at which the gage is located. The right bank is low and will overflow under the trestle on this bank. The left bank is high and is partly riprap. At low stages there will be some backwater at the south bank. There is but one channel at all stages. The bed of the stream is composed of gravel and is shifting. The bench mark is the top of the south side of the steel caisson at the east end of the middle pier of the Main Street Bridge. Its elevation is 16.50 feet above the zero of the gage.

The flour mill ditch (Byer's) takes 100 second-feet or more of water

about a mile and a half above the gage and returns it to the river about 200 feet above the gage, so that it interferes with the measurements in no way except for a time during very low water, when the water is drawn down and then stored again. The gage was read only when the flow was normal. This accounts for the few gage heights during the summer.

The Farmers Mill ditch does not affect the reading of the gage when above 4 feet. When the water is below that height it takes about 40 second-feet of water from the river above the gage and returns it above the bridge, where measurements are made; so for low stages of the river the amount of water in the ditch should be taken out from the measured discharge in making curve and rating table and should then be added to the discharge taken from the table.

On June 15, 1904, a gage was placed on the Farmers Mill ditch and read from that time until the station was temporarily abandoned, September 4, on account of fluctuations caused by the mill above and the building of a concrete diversion dam below the gage.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurements of Umatilla River at Pendleton, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
February 18	H. A. Yates	100	252	4.20	2.80	1,065
March 7	do	131	482	5.67	4.58	2,735
March 9	do	182	864	6.54	6.45	5,645
March 23	do	108	356	4.00	2.95	1,430
April 13	Brainard and Saxton	191	816	6.86	7.05	5,597
May 24	W. C. Sawyer	101	285	4.16	2.70	1,185
May 28	do	100	263	2.28	1.90	570 [b]
June 7	do	87	253	2.07	2.00	492 [c]
July 12	do	16	14.5	3.07	1.25	6 [d]
August 14 [a]	do	25	12	2.30	.95	28
August 14	do	28	12.5	2.30	.95	28.5

[a] Wading 800 feet above station.
[b] 30 second-feet subtracted for canal.
[c] 33 second-feet subtracted for canal.
[d] 40 second-feet subtracted for canal.

Mean daily gage height, in feet, of Umatilla River at Pendleton, Oreg., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	1.75	1.90	2.90	4.00	3.38	1.82	1.25
2	1.70	1.85	2.95	4.15	3.18	1.92	1.25
3	1.65	1.80	2.85	4.72	3.42	2.05	1.41
4	1.65	1.80	2.80	4.52	3.42	2.08	1.25
5	1.65	1.90	2.80	4.28	3.30	2.05	1.30
6	1.60	1.90	3.18	5.22	3.10	2.05	1.20
7	1.60	1.90	4.62	4.75	3.10	2.02	1.20
8	1.67	1.85	6.60	4.35	2.95	2.00	1.20
9	1.68	1.80	6.35	4.85	2.98	1.92	1.20
10	1.75	1.70	5.08	5.80	3.10	1.90	1.20
11	2.15	1.70	4.32	6.70	3.12	1.85	1.20
12	2.37	1.75	3.75	6.60	3.15	1.75	1.25
13	2.95	1.75	.....	7.14	3.15	1.70	1.15
14	2.90	1.70	3.10	7.04	3.08	1.65	.....
15	3.23	1.72	3.40	6.74	3.00	1.55	.....
16	3.17	3.05	3.20	5.90	2.80	1.50	.....
17	3.05	3.02	3.18	5.32	2.78	1.50	.....
18	2.95	2.80	3.32	5.08	2.75	1.45	.....
19	2.72	2.70	3.35	5.45	2.90	1.45	.....
20	2.50	2.60	3.50	5.75	2.95	1.38	.....
21	2.35	2.50	3.45	5.28	2.95	1.30	.....
22	2.53	2.82	3.20	4.85	2.75	1.30	.....
23	2.87	3.30	3.05	4.20	2.70	1.30	.....
24	2.85	3.28	2.75	3.72	2.65	1.30	.....
25	2.60	3.20	2.60	3.65	2.38	1.30	.....
26	2.55	3.18	2.50	4.28	2.20	1.30	.....
27	2.35	3.30	2.50	4.52	2.10	1.25	.....
28	2.15	3.10	2.60	4.40	1.95	1.25	.....
29	2.05	2.92	3.90	4.20	1.85	1.25	.....
30	2.00	.....	5.10	3.72	1.78	1.25	.....
31	1.95	.....	4.45	.....	1.75	.....	.....

UMATILLA RIVER AT YOAKUM, OREG.

This station was established May 5, 1903, by N. S. Dils. It is located one-half mile east of Yoakum station of the Oregon Railroad and Navigation Company, at what is known as the Yoakum wagon bridge. The original gage is a vertical split rail spiked to the face of the south abutment on the upstream side. On September 5, 1903, a new gage, consisting of a 2 by 6 inch timber, 14 feet long, was spiked in a vertical position to the right abutment on the opposite side of the river from the original gage. The new gage was necessary to obtain gage readings at low stages. It is set at the same datum as the original gage and both gages read the same. During 1904 readings have been made once each day by Luther Dehaven. Discharge measurements are made from the single-span wagon bridge at which both gages are located. The initial point for soundings is the end of the lower chord of the upstream truss on the left bank. The channel is straight for 1,000 feet above and below the station. The current

is swift and has a well-distributed velocity. Both banks are high and are composed of gravel. The right bank will not overflow. The left bank will overflow only at extreme flood stages. The bed of the stream is composed of gravel and is permanent. There is but one channel at all stages. The bench mark is a 60-penny nail and two 8-penny nails driven side by side into the second timber from the top of the left abutment near the old gage. The elevation of the bench mark is 13.00 feet above the zero of both gages.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurements of Umatilla River at Yoakum, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
March 30	H. A. Yates	76	530	9.80	8.50	5,215
April 12	do	76	616	10.67	9.65	6,575
April 28	W. C. Sawyer	76	430	7.26	7.15	3,116
May 20	do	76	316	4.60	5.55	1,453
May 31	do	76	195	2.46	4.30	480
July 31	do	76	141	.98	3.36	138
September 3	do	72	99	.41	2.84	40

Mean daily gage height, in feet, of Umatilla River at Yoakum, Oreg., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.40	4.50	6.00	.....	6.30	4.30	3.10	2.80	2.80	3.00	3.20	3.20
2	4.30	4.50	5.90	.....	6.60	4.30	3.10	2.80	2.80	3.00	3.20	3.20
3	4.30	4.40	5.80	.....	6.60	4.30	3.10	2.70	2.80	3.00	3.20	3.20
4	4.30	4.30	5.80	.....	6.60	4.30	3.80	2.70	2.80	3.00	3.20	3.20
5	4.30	4.20	5.80	.....	6.50	4.30	3.70	2.70	2.90	3.00	3.20	3.20
6	4.30	4.20	6.00	.....	6.40	4.40	3.60	2.70	2.90	3.00	3.20	3.20
7	4.30	4.30	7.10	.....	6.30	4.30	3.60	2.70	2.90	3.00	3.20	3.20
8	4.40	4.50	9.70	.....	5.80	4.30	3.50	2.70	2.90	3.00	3.20	3.20
9	4.40	4.50	9.00	.....	5.80	4.20	3.50	2.70	2.90	3.00	3.20	3.20
10	4.50	4.50	8.70	.....	6.00	4.10	3.50	2.70	2.90	3.00	3.20	3.20
11	4.90	4.60	8.20	.....	6.00	4.00	3.40	2.70	2.90	3.20	3.20	3.20
12	5.10	4.60	7.00	.....	5.90	4.00	3.50	2.70	2.90	3.10	3.20	3.20
13	5.60	4.60	6.40	.....	5.80	4.00	3.40	2.70	2.90	3.10	3.20	3.20
14	5.70	4.60	6.30	.....	5.60	3.90	3.40	2.70	2.90	3.20	3.20	3.20
15	6.10	4.70	6.50	.....	5.50	3.80	3.40	2.70	2.90	3.30	.....	3.20
16	6.00	6.00	6.40	.....	5.40	3.80	3.40	2.70	2.90	3.30	3.20	3.20
17	6.00	6.10	6.30	.....	5.40	3.60	3.40	2.70	2.90	3.40	3.20	3.20
18	5.90	5.90	6.40	.....	5.50	3.50	3.30	2.70	2.90	3.30	3.20	3.30
19	5.70	5.70	6.40	.....	5.50	3.40	3.30	2.70	2.90	3.30	3.20	3.30
20	5.60	5.50	6.40	.....	5.40	3.40	3.30	2.70	2.90	3.30	3.20	3.40
21	5.40	5.60	6.30	.....	5.40	3.40	3.20	2.70	3.00	3.30	3.20	3.40
22	5.20	6.20	6.20	.....	5.40	3.30	3.20	2.80	3.00	3.30	3.20	3.40
23	5.00	6.40	6.20	.....	5.20	3.30	3.10	2.80	3.30	3.20	3.20	3.40
24	5.30	6.50	6.20	.....	5.10	3.30	3.00	2.80	3.20	3.20	3.20	3.40

Mean daily gage height, in feet, of Umatilla River at Yoakum, Oreg., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
25	5.40	6.40	6.10	.....	4.90	3.30	3.00	2.80	3.10	3.20	3.20	3.40
26	5.30	6.40	5.70	.....	4.70	3.30	3.00	2.80	3.00	3.20	3.20	3.40
27	5.10	6.30	5.70	.....	4.60	3.20	2.90	2.80	3.00	3.20	3.20	3.40
28	5.00	6.20	5.90	7.10	4.60	3.10	2.90	2.80	3.00	3.20	3.20	3.40
29	4.90	6.10	7.70	6.70	4.50	3.10	2.90	2.80	3.00	3.20	3.20	3.50
30	4.70	.....	8.40	6.60	4.40	3.10	2.80	2.80	3.00	3.20	3.20	3.70
31	4.70	.....	7.50	.....	4.40	.....	2.80	2.80	.....	3.20	.....	3.80

Rating table for Umatilla River at Yoakum, Oreg., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.70	30	4.20	457	5.60	1,475	7.00	2,971
2.80	41	4.30	510	5.70	1,568	7.20	3,217
2.90	53	4.40	567	5.80	1,663	7.40	3,469
3.00	65	4.50	628	5.90	1,760	7.60	3,730
3.10	78	4.60	691	6.00	1,859	7.80	3,995
3.20	95	4.70	758	6.10	1,960	8.00	4,270
3.30	116	4.80	827	6.20	2,064	8.20	4,551
3.40	141	4.90	899	6.30	2,170	8.40	4,837
3.50	170	5.00	973	6.40	2,279	8.60	5,133
3.60	201	5.10	1,050	6.50	2,389	8.80	5,434
3.70	235	5.20	1,131	6.60	2,501	9.00	5,741
3.80	272	5.30	1,214	6.70	2,615	9.50	6,541
3.90	313	5.40	1,299	6.80	2,731	10.00	7,382
4.00	358	5.50	1,386	6.90	2,850	10.50	8,252
4.10	406						

The above table is applicable only for open-channel conditions. It is based upon 7 discharge measurements made during 1904 and is fairly well defined. Above gage height 10.00 feet the rating curve is a tangent, the difference being 174 per tenth.

Estimated monthly discharge of Umatilla River at Yoakum, Oreg., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January	1,960	510	1,046	64,320
February	2,389	457	1,264	72,710
March	6,871	1,568	2,730	167,900
April [a]	.....	.....	4,174	248,400
May	2,501	567	1,487	91,430
June	567	78	288	17,140
July	272	41	120	7,379
August	41	30	34.3	2,109
September	116	41	58.5	3,481
October	141	65	90.5	5,565
November	95	95	95.0	5,653
December	272	95	122	7,501
The year	.....	.....	959	693,500

[a] Discharge estimated April 1-27, inclusive.

UMATILLA RIVER NEAR UMATILLA, OREG.

This station was established October 21, 1903, by John H. Lewis. It is located about 2 miles above Umatilla, Oreg., and about one-fourth mile below the diversion dam of the Oregon Land and Water Company. This dam diverts water into an irrigation ditch on the left bank. The inclined gage is on the left bank 45 feet below the cable and is in two sections. Both sections are made of 2 by 6 inch timber fastened by bolts which are cemented into the rock. The lower section reads from 1.2 to 3.5 feet. The upper section reads from 3.5 to 10.8 feet. The gage is read every other day by B. V. Pompella. Gage readings are taken every day during floods. Discharge measurements are made by means of a ⅝-inch wire cable, car, tagged wire, and stay wire. The cable has a span of 210 feet. The initial point for soundings is the zero mark on the tag wire, directly over the vertical portion of the left bank. The channel is straight for 500 feet above and for 1,000 feet below the cable. The current is swift. Both banks are high and rocky and will not overflow. The bed of the stream is composed of solid rock, free from vegetation, and permanent. The bench mark is the head of a bolt cemented in the solid rock 1½ feet upstream from the gage rod. Its elevation is 10.30 feet above the zero of the gage. To obtain the total discharge of the river, the discharge of the irrigation ditch must be added to that of the river at the cable. The rapids just above Umatilla prevent

backwater from Columbia River from affecting the gage heights at the station.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurements of Umatilla River near Umatilla, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
March 18	J. H. Lewis	178	420	5.02	4.40	2,190
March 30	do	183	742	7.40	6.30	5,484
April 11	H. A. Yates	187	760	8.00	6.65	6,030
May 13	Murphy and Sawyer	175	317	4.78	4.00	1,507
August 13 [a]	W. C. Sawyer	20	8	0.78	1.86	7
October 24	do	50	40	1.58	2.42	62

[a] Made at different section.

Discharge measurements of Oregon Land and Water Company's ditch near Umatilla, Oreg., in 1904.

Date.	Discharge.	Date.	Discharge.
	Second-feet.		*Second-feet.*
March 18	0.0	May 13	12.4
March 30	0.0	October 24 [a]	13
April 11	15		

[a] Estimated.

Mean daily gage height, in feet, of Umatilla River near Umatilla, Oreg., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.30	3.50	4.25	.....	.....	.....	2.15	.....	1.95	2.35	.....	.....
2	3.30	3.40	.....	5.40	4.55	3.20	.....	2.20	.....	.....	2.35	2.55
3	3.30	3.40	4.20	5.50	4.40	.....	2.15	.....	2.00	2.35	.....	.....
4	3.30	3.30	.....	5.65	.....	3.30	.....	2.10	.....	.....	2.35	2.55
5	3.30	3.30	4.25	5.60	4.30	3.20	3.10	.....	2.00	2.30	.....	.....
6	3.20	3.30	.....	5.50	4.25	.....	.....	2.05	.....	.....	2.35	2.55
7	3.20	3.40	4.80	5.90	4.25	3.15	3.00	.....	2.00	2.15	.....	.....
8	3.20	3.40	.....	5.80	4.25	3.10	.....	2.00	.....	.....	2.30	2.55
9	3.20	3.40	7.30	.....	4.15	3.10	2.80	.....	2.00	2.15	.....	.....
10	3.30	3.40	.....	6.00	4.05	3.05	.....	2.00	.....	.....	2.35	2.55
11	3.50	3.30	5.45	6.60	4.20	3.00	2.70	.....	2.00	2.30	.....	.....
12	3.70	3.30	.....	6.90	4.15	2.85	.....	1.95	.....	.....	2.35	2.55
13	3.80	3.30	4.80	7.05	4.00	2.85	3.00	.....	2.00	2.35	.....	.....
14	4.10	3.30	.....	7.40	4.00	2.80	.....	1.90	.....	.....	2.35	2.55
15	4.00	3.30	4.75	7.65	3.95	2.80	2.60	.....	2.20	2.45	.....	.....
16	4.20	3.90	.....	7.40	3.95	.....	.....	1.90	.....	2.45	2.40	2.60
17	4.20	4.40	4.60	6.45	3.90	2.75	2.60	.....	2.20	.....	.....	.....
18	4.10	.....	.....	.....	3.85	.....	.....	1.90	.....	2.45	2.35	2.60
19	4.10	4.20	4.40	5.40	3.85	2.70	2.55	.....	2.20	.....	.....	.....

Mean daily height, in feet, of Umatilla River near Umatilla, Oreg., for 1904—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
20	4.00	.....	.....	.....	3.90	.....	.....	1.90	.....	2.45	2.40	2.60
21	3.90	4.00	4.40	5.80	3.80	2.60	2.50	.....	2.20	.....	.....	.....
22	3.80	.....	4.45	.....	.....	.....	.....	1.90	.....	2.45	2.35	2.65
23	3.70	4.40	4.40	5.20	3.80	2.50	2.50	.....	2.20	.....	.....	.....
24	3.70	.....	4.35	5.00	3.80	.....	.....	1.90	.....	2.40	2.40	2.65
25	3.80	4.30	4.35	.....	3.70	2.50	2.50	.....	2.40	.....	.....	.....
26	3.80	.....	4.20	4.20	3.60	.....	.....	1.95	.....	2.40	2.40	2.65
27	3.80	4.20	4.10	4.50	3.45	2.45	2.40	.....	2.35	.....	.....	.....
28	3.70	.....	4.00	4.60	3.35	.....	.....	1.95	.....	2.40	2.50	2.65
29	3.60	4.20	4.80	.....	3.25	2.30	2.25	.....	2.30	.....	.....	.....
30	3.60	.....	6.45	4.80	3.20	.....	.....	1.95	.....	2.30	2.50	2.65
31	3.50	.....	5.95	.....	3.15	.....	2.20	.....	.....	2.30	.....	.....

Rating table for Umatilla River near Umatilla, Oreg., from October 22, 1903, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.90	9	3.20	531	4.50	2,200	5.80	4,444
2.00	14	3.30	627	4.60	2,355	5.90	4,636
2.10	21	3.40	731	4.70	2,512	6.00	4,830
2.20	30	3.50	843	4.80	2,672	6.20	5,218
2.30	43	3.60	962	4.90	2,835	6.40	5,606
2.40	62	3.70	1,085	5.00	3,000	6.60	5,994
2.50	88	3.80	1,212	5.10	3,169	6.80	6,382
2.60	124	3.90	1,342	5.20	3,342	7.00	6,770
2.70	171	4.00	1,475	5.30	3,518	7.20	7,158
2.80	227	4.10	1,612	5.40	3,697	7.40	7,546
2.90	291	4.20	1,753	5.50	3,880	7.60	7,934
3.00	363	4.30	1,898	5.60	4,066	7.80	8,322
3.10	443	4.40	2,047	5.70	4,254	8.00	8,710

The above table is applicable only for open-channel conditions. It is based upon 8 discharge measurements made during 1903 and 1904. It is well defined between gage heights 1.85 feet and 6.15 feet. The table has been extended above 6.15 feet. Above gage height 6.00 feet the rating curve is a tangent, the difference being 194 per tenth.

Estimated monthly discharge of Umatilla River near Umatilla, Oreg., for 1903 and 1904.

Month.	Discharge in second-feet.[a]			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
1903.				
October 22-31	171	124	134	2,658
November	2,512	88	810	48,200
December	1,753	531	1,102	67,760
1904.				
January	1,753	531	1,049	64,520
February	2,047	627	1,219	70,110
March	7,352	1,475	2,827	173,900
April	8,031	1,753	4,371	260,100
May	2,512	486	1,415	87,020
June	627	30	269	16,030
July	443	25	145	8,886
August	30	9	13	807
September	62	11	27	1,617
October	74	25	55	3,366
November	88	43	58	3,437
December	146	88	121	7,462
The year	8,031	9	964	697,200

[a] Discharge for missing gage heights interpolated.

M'KAY CREEK NEAR PENDLETON, OREG.

This station was established May 23, 1903, by E. I. Davis. It was located at the footbridge near the residence of C. W. Lyman, 2 miles west of Pendleton, Oreg. The gage was a vertical 1 by 6 inch board 11 feet long nailed to a post which is set in the bed of the stream and braced to a large poplar tree. It was about 200 feet north of C. W. Lyman's house and is about 150 feet below the footbridge, on the left bank. It was read twice each day by C. W. Lyman. Discharge measurements were made from the footbridge of 65-foot span, above the gage. The initial point for soundings was the end of the log, of which the bridge consists, on the right bank. The channel is straight for 150 feet above and 100 feet below the bridge. The current has a good velocity at ordinary stages. Both banks are high, not liable to overflow, and are without trees. There is but one channel at all stages. The bed of the stream is composed of gravel, free from vegetation, and permanent. The bench mark was a nail in a blaze on a root of the poplar tree to which the gage was braced. Its

elevation was 5.82 feet above the zero of the gage. The station was abandoned July 6, 1904.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurements of McKay Creek near Pendleton, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
March 5	H. A. Yates	40	126	3.40	2.20	434
March 11	do	42	150	4.90	3.05	740
April 12	do	43	182	6.00	3.90	1,100
June 2 [a]	W. C. Sawyer	16	14.5	1.73	1.22	25

[a] Made at different section.

Mean daily gage height, in feet, of McKay Creek near Pendleton, Oreg., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	1.55	1.50	2.00	3.35	2.00	1.15	0.90
2	1.45	1.50	2.00	3.30	2.00	1.25	.90
3	1.40	1.45	2.00	3.40	2.00	1.25	.90
4	1.40	1.40	2.00	3.40	1.95	1.20	1.60
5	1.40	1.50	2.20	3.28	1.90	1.20	1.45
6	1.40	1.50	2.25	3.80	1.90	1.20	1.30
7	1.40	1.50	3.20	3.40	1.85	1.20	.....
8	1.40	1.50	4.10	3.25	1.80	1.20	.....
9	1.50	1.50	3.95	3.80	1.75	1.20	.....
10	1.50	1.50	3.35	4.00	1.70	1.20	.....
11	1.70	1.50	3.00	3.80	1.70	1.20	.....
12	1.90	1.50	2.50	3.80	1.60	1.20	.....
13	2.00	2.35	2.45	3.80	1.60	1.20	.....
14	2.30	2.50	2.40	3.80	1.55	1.20	.....
15	2.40	2.50	2.40	3.55	1.55	1.10	.....
16	2.30	2.35	2.40	3.50	1.50	1.05	.....
17	2.15	2.20	2.40	3.30	1.50	1.00	.....
18	2.10	2.15	2.40	3.05	1.50	1.00	.....
19	2.00	2.00	2.40	3.00	1.45	1.00	.....
20	1.85	2.00	2.42	2.90	1.45	.97	.....
21	1.85	1.90	2.40	2.85	1.40	.95	.....
22	1.95	2.40	2.25	2.80	1.40	.90	.....
23	2.10	2.50	2.12	2.55	1.38	.90	.....
24	2.00	2.50	2.00	2.40	1.35	.90	.....
25	2.00	2.25	1.95	2.30	1.30	.90	.....
26	1.90	2.20	1.90	2.30	1.28	.90	.....
27	1.85	2.15	1.90	2.25	1.25	.90	.....
28	1.75	2.10	2.10	2.20	1.20	.90	.....
29	1.70	2.00	3.35	2.10	1.20	.90	.....
30	1.60	.....	4.25	2.00	1.20	.90	.....
31	1.55	.....	3.40	.....	1.18	.....	.....

JOHN DAY RIVER AT M'DONALD, OREG.

This station was established December 16, 1904, by W. C. Sawyer. It is located at the ferry at McDonald, 16 miles above the mouth of the river, and 18 miles southwest of Arlington, Oreg. An inclined staff gage in two sections is fastened to old bridge timbers 183 feet upstream from the ferry cable. The lower section reads from 1 to 2 feet; the upper section reads from 2 to 11 feet. The gage is read once each day by William Murray. Discharge measurements are made by means of a car suspended from the ferry cable. The car is provided with steel snatch blocks and lever for passing the ferry traveler. The initial point for soundings is the face of the support on the right bank. The channel is straight for one-half mile above and below the cable. The current is swift. Both banks are high, free from vegetation, and do not overflow. The bed of the stream is composed of clean sand and gravel, and is slightly shifting. There is but one channel at all stages. Bench mark No. 1 is the top of the corner stone under the southeast corner of barn near the gage. Its elevation is 15.32 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurements of John Day River at McDonald, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
October 26	W. C. Sawyer	263	602	0.96	2.00	580
December 16	do	262	627	.90	1.98	570

Mean daily gage height, in feet, of John Day River at McDonald, Oreg., for 1904.

Day.	Nov.	Dec.	Day.	Nov.	Dec.	Day.	Nov.	Dec.
1		1.95	12		1.95	22	1.90	2.00
2		1.95	13		2.01	23	1.90	2.00
3		1.95	14	1.70	2.00	24	1.95	2.00
4		1.95	15	1.70	2.00	25	1.95	2.00
5		1.95	16	1.70	1.95	26	1.95	2.00
6		1.90	17	1.80	2.00	27	1.95	1.85
7		1.80	18	1.80	2.00	28	1.95	1.80
8		1.70	19	1.90	1.95	29	1.95	1.65
9		1.70	20	1.90	1.90	30	1.95	1.85
10		1.80	21	1.90	1.95	31		1.90
11		1.90						

DESCHUTES RIVER NEAR BEND, OREG.

This station was established December 22, 1904, by W. C. Sawyer. It is located at the wagon bridge known as Sizemore's bridge, 1¼ miles south of Bend, Oreg. A plain staff gage, graduated to feet and tenths, is spiked vertically to the sixteenth bent of the bridge, 335 feet from the initial point for soundings. It is read once each day by Dr. W. S. Nichol, who is paid by the Deschutes Irrigation and Power Company. Discharge measurements are made from the downstream side of the bridge to which the gage is attached. The initial point for soundings is a point marked with black paint at the west end of the bridge, downstream side. The channel is straight for 300 feet above and below the station. The current is swift, and both banks are high. The left bank is subject to overflow at extreme high water. The bed of the stream is composed of rock and gravel, free from vegetation, and is permanent. There is but one channel at all stages. The bench mark is a copper bolt cemented in a large bowlder near the edge of the water, about 100 feet above the east end of the bridge. Its elevation is 5.20 feet above the zero of the gage.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Discharge measurement of Deschutes River near Bend, Oreg., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
December 21	W. C. Sawyer	348	834	2.89	2.00	2,412

Mean daily gage height, in feet, of Deschutes River near Bend, Oreg., for 1904.

Day.	Dec.	Day.	Dec.	Day.	Dec.
22	2.0	26	2.0	29	2.0
23	2.0	27	1.9	30	2.0
24	2.0	28	1.9	31	2.0
25	2.0				

DESCHUTES RIVER (EAST FORK) AT ODELL, OREG.

This station was established December 25, 1904, by W. C. Sawyer. It is located at the county wagon bridge at Odell, Oreg. A plain staff gage, graduated to feet and tenths, is spiked vertically to logs projecting from a milk house belonging to the observer. It is read once each day by Charles Graves. Discharge measurements are made from the bridge at all ordinary stages. At extreme high water a foot log below the bridge is used. The initial point for soundings at the

bridge is a 10-penny nail driven into a log at the south end of the bridge, downstream side. The initial point at the foot log is a 10-penny nail driven into the north end of the foot log. The channel is curved. The current is swift. Both banks are low and clean. The left bank is liable to overflow at high water. The bed of the stream is composed of gravel and sand, free from vegetation, and is permanent. There are two or more channels at the bridge during high water and one at low and ordinary stages. There is but one channel at all stages at the foot log. The bench mark is a 60-penny nail in the base of a jack-pine tree used for gate post in the yard fence of the observer. Its elevation is 7.87 feet above the zero of the gage rod.

The observations at this station during 1904 have been made under the direction of John T. Whistler, district engineer.

Mean daily gage height, in feet, of Deschutes River (East Fork) at Odell, Oreg., for 1904.

Day.	Dec.	Day.	Dec.	Day.	Dec.
26	2.5	28	2.8	30	2.7
27	2.5	29	2.7	31	2.7

MISCELLANEOUS MEASUREMENTS IN COLUMBIA RIVER DRAINAGE BASIN.

The following discharge measurements were made in Columbia River drainage basin in 1904 under the direction of D. W. Ross, C. C. Babb, John T. Whistler, and T. A. Noble, district engineers:

Miscellaneous measurements in Idaho in 1904.

Date.	Stream.	Locality.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
			Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
Aug. 31	Aster Creek	"Soldier Crossing"		31	0.70		20.4
Mar. 20	Clearwater River	Railway bridge between Lapwai and Potlatch Junction.	594	3,493	5.44		19,018
July 19	Big Payette	At outlet of Big Payette Lake.					812
June 28	Conant Creek	Near Squirrel		29	1.94		56
June 12	Fish Creek	10 miles from Carey, above all canals.					49
Aug. 31	Lewis Lake Outlet	"Soldier Crossing," near falls.		161	1.3		220
Aug. 30	Shoshone Lake Outlet.	3 miles above Lewis Lake		169	1.1		183
Aug. 26	Snake River (Henry Fork).	Ford on Yellowstone Park road.		48	1.2		60
Aug. 17	Snake River (North Fork).	Island Park bridge		414	2.4		1,000
Sept. 16	Spokane River	Old Fort Sherman at outlet of Cœur d'Alene Lake.	450	1,043	.93	[a] 2,119	1,969

[a] Elevation of water surface above sea level.

Tributaries of the South Fork of Snake River, north side, from Sunnydell, Idaho, to Wyoming State line.

Date.	Stream.	Discharge.	Remarks.
Aug. 10	Lyman, or Lyon, Creek	0.4	Low. Above Sunnydell. Water rights disputed. Drainage area 36 miles.
Aug. 10	Hawley Springs	.8	Normal. Below Heise P. O. ½ mile.
Aug. 10	Kelly Creek	.7	Low. Above Heise 1 mile. Used on Kelly farm.
July 28	Rainy Creek	36	Low. In Swan Valley, 5 miles below Irwin. Entire summer flow used. Water rights in dispute. Gaged above all canals. Drainage area 70 miles.
July 29	Palisade Creek	106	Low. Gaged above all canals. In Swan Valley, 5 miles above Irwin. Drainage area 80 miles.
July 29	Sheep Creek	3.3	Low. In Swan Valley, 5 miles above Irwin. Flow taken by Tolman's ditch.
July 29	Elk Creek	105	Low. In Grand Valley, near Rosa. Gaged below all ditches.
July 30	Indian Creek	34	Low. In Grand Valley, near Rosa. Gaged below all canals. Trouble over water rights. Highest creek up river on north side used for irrigation in Idaho. Drainage area 50 miles.

Tributaries of the South Fork of Snake River, south side, from Wyoming State line to Poplar, Idaho.

Date.	Stream.	Discharge.	Remarks.
July 30	Williams Creek	1.3	Low. Below McCoy Creek 2 miles. Used for irrigation.
July 31	Edwards Creek	1.5	Low. Below McCoy Creek 5 miles. Entire summer flow used.
July 31	Cabin Creek	1.0	Low. Entire summer flow used.
July 31	Deer Creek	1.0	Do.
July 31	Summit Creek	1.3	Do.
July 31	Alder Creek	.7	Low. In Swan Valley, 15 miles below McCoy Creek. Entire summer flow used.
July 31	Dry Hollow Creek	.3	Low. Entire summer flow used.
July 31	Porcupine Creek	1.7	Do.
July 31	Deer Creek	1.8	Do.
Aug. 1	Indian Creek	3.0	Do.
Aug. 1	Squaw Creek	.7	Do.
Aug. 1	Fall Creek	23.9	Low. In Swan Valley. Used for irrigation. Drainage area 45 miles.
Aug. 1	Pritchard Creek	3.3	Low. In Conant Valley. Used for irrigation.

Tributaries of the South Fork of Snake River, south side, from Wyoming State line to Poplar, Idaho—Continued.

Date.	Stream.	Discharge.	Remarks.
Aug. 2	Garden Creek	1.0	Low. Entire summer flow used for irrigation.
Aug. 2	Granite Creek	.8	Do.
Aug. 2	Antelope Creek	1.8	Low. Entire summer flow used for irrigation. Drainage area 35 miles.
Aug. 2	Little Pine Creek	.3	Low. Filings have been made on flow.

Tributaries of the North Fork of Snake River above Marysville, Idaho.

Date.	Stream.	Discharge.	Remarks.
Aug. 15	Hill Creek	0.3	Low. North bank Snake opposite Marysville, near ford. Entire summer flow used.
Aug. 17	Thurman Creek	18	Bank full; spring fed. 30 miles from Marysville. Used for irrigation.
Aug. 17	Thurman Springs	.2	Normal. Used for irrigation.
Aug. 17	West Bald Cabin Springs	.2	Do.
Aug. 17	East Bald Cabin Springs	1.5	Do.
Aug. 17	Green Springs	.6	Do.
Aug. 17	Osborn Creek	6.0	Bank full; spring fed. Used for irrigation.
Aug. 18	Blue Springs	3.6	Normal. Water rights claimed.
Aug. 18	Tom Creek	.5	Normal. Used for irrigation. Flows into Buffalo Creek.
Aug. 18	Grizzly Spring	5.3	Normal. Used for irrigation. Tributary to Shotgun Creek.
Aug. 19	Ice House Creek	9.0	About normal; spring fed. Used for irrigation. Tributary to Shotgun Creek. Drainage area 35 miles.
Aug. 20	Willow Creek	3.0	Low. Used for irrigation. Tributary of Shotgun Creek. Ownership disputed. Drainage area 20 miles.
Aug. 20	Caldwell Spring No. 1	.5	Normal. In Icehouse Park. Upper watershed of Icehouse Creek. Used for irrigation and domestic purposes.
Aug. 20	Caldwell Spring No. 2	.3	Normal. Same as spring No. 1.
Aug. 21	Taylor Creek	.6	Low. Tributary of Shotgun Creek. Used for irrigation. Ownership disputed.
Aug. 22	Sorenson Spring	.8	Low. Rises between Taylor and Sheridan creeks above Sheridan ranch. Used for irrigation. Ownership disputed.
Aug. 22	Shotgun Creek	68	Gaged at Trude's bridge, about 1 mile above mouth. Drainage area 145 miles.

Tributaries of Henry Fork, a tributary of North Fork of Snake River, east bank, going upstream.

Date.	Stream.	Discharge.	Remarks.
Aug. 27	Meadow Creek	8.8	Bank full; spring fed. Used by ranchers.
Aug. 22	Pine Creek	.9	Mid height. Entire summer flow used for irrigation.
Aug. 23	Coolie Creek	12.3	Mid height. Used for irrigation.
Aug. 23	Snow Water Creek	.2	Low. Entire summer flow used.
Aug. 23	Bear or Little Spring	.5	Normal. Used for irrigation.
Aug. 23	Canyon Creek	.8	Do.
Aug. 23	Thompson Springs	5.0	Do.
Aug. 23	Garner Spring	.9	Do.
Aug. 23	Jessie Creek	3.0	Low.
Aug. 24	Twin Creek	6.8	Below normal.

Tributaries of Henry Lake, Idaho.

Date.	Stream.	Discharge.	Remarks
Aug. 24	Howard Creek	11	Low. Used for irrigation.
Aug. 24	Tahgee Creek	19	Do.
Aug. 25	Whitman Spring	1.7	Normal. Used to supply fish pond.
Aug. 25	Rock Springs	.7	Normal. Used for irrigation.
Aug. 25	Howe Creek	.7	Normal. Owned by Henry Lake Shooting Club. Used by rancher to make proof on desert entry.
Aug. 25	Sherwood Springs	1.2	Normal. Used for irrigation.
Aug. 25	Canyon Creek	.6	Low. Used for domestic purposes.
Aug. 25	Oswald Creek	.3	Low. Used for irrigation.
Aug. 25	Big Spring	1.2	Normal. Used for irrigation. Tributary of Timber Creek.
Aug. 25	Golf Spring	.7	Normal.
Aug. 25	Timber Creek	1.0	Gaged above confluence with Oswald, Big Spring, and Golf Spring creeks. Used for irrigation.
Aug. 26	Johnson Creek	3.2	Rises on Sherman ranch. Used on Sherman and Staley ranches.
Aug. 26	Duck Creek	9.6	Used on Sherman ranch.
Aug. 26	Rock Creek	6.4	Do.
Aug. 26	Hope Creek	2.4	Do.

Miscellaneous measurements in Montana in 1904.

SUBDRAINAGE BASIN OF MISSOULA RIVER.

Date.	Stream.	Locality.	Area of section.	Mean velocity.	Gage height.	Discharge.
			Sq. feet.	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
May 21	New Hedge ditch	Grantsdale	19	2.68	2.35	[a] 51
Aug. 26	do	do	27	4.00	3.15	[a] 107
May 21	Republican ditch	do	37	2.35	2.30	[a] 86
Aug. 26	do	do	35	3.00	2.60	[a] 104
May 19	Rattlesnake Creek	Missoula	111	5.82	.....	646

[a] Measurements made directly above the United States Geological Survey gaging station at Grantsdale, on Bitterroot River.

Miscellaneous measurements in Oregon in 1904.

Date.	Stream.	Locality.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
			Feet.	*Square feet.*	*Ft. per second.*	*Feet.*	*Second-feet.*
July 15	Abiqua Creek	Highway bridge, near Silverton.	.....	.....	.....	1.2	82
Apr. 9	Bully Creek	Bridge at Westfall	25	58	5.64	.....	324
Apr. 11	do	do	25	92	6.95	.....	643
July 22	Crescent Creek	Outlet Crescent Lake	105	303	.64	.....	195
Aug. 1	do	do	105	279	.60	.....	166
July 23	do	Above Deschutes River	34	71	2.70	.....	192
Sept. 12	Davis Creek	½ mile above mouth	98	191	1.50	.....	287
Aug. 6	Deschutes River	½ mile below Crescent Creek	72	97	2.25	.....	219
July 21	Deschutes River, East Branch.	Odell	22	16	2.10	.....	97
Aug. 21	do	do	24	38	1.81	.....	69
Sept. 16	do	Rosland	65	120	2.05	.....	246
July 23	Deschutes River, West Branch.	Royce's ranch, T. 24 S., R. 7 E.	24	27	3.22	.....	86
Sept. 11	do	Sec. 8, T. 21 S., R. 8 E	104	514	1.10	.....	566
July 16	Molalla River[a]	Highway bridge, near Canby.	.....	.....	.....	.8	247
July 28	Outlet	Odell Lake	54	54	2.37	.....	128
Oct. 25	Rock Creek	France	4	1.3	.73	.....	.9
July 30	Rogue River[a]	Highway bridge, at Grants Pass.	.....	.....	.....	.9	2,254
Nov. 2	Santiam River[a]	Scio ferry, near Marion	.....	.....	.....	.1	726
July 15	Silver Creek[a]	Union Light and Power Co. station, near Silverton.	.....	.....	.....	.8	28
Aug. 7	do	do	.....	.....	.....	.0	11
Mar. 10	Wildhorse Creek	Pendleton	34	114	2.55	.....	290
Oct. 20	Willamette River[a]	Highway bridge, at Eugene	.....	.....	.....	.4	1,370

[a] Miscellaneous measurements furnished to the United States Geological Survey by Mr. J. H. Cunningham, civil and hydraulic engineer, Portland, Oreg.

Miscellaneous measurements in Washington, 1904.

Date.	Stream.	Locality.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge
			Feet.	*Square feet.*	*Ft. per second.*	*Feet.*	*Second feet.*
Aug. 27	American River	Mouth near Niles		66	1.64		108
Aug. 26	Bumping River	Bumping Lake		110	1.05		116
Sept. 21	Cabin Creek	Near Easton		6.2	1.11		6.9
Sept. 22	Clealum River	2 miles above Lake Clealum		155	1.33		206
Oct. 17	Colville River	Kettle Falls	125	257	.82	15.7	210
Apr. 6	Cottonwood Creek	Rock Lake	21	18.9	1.69		32
May 7	do	do	4	1.9	2.12		4.1
June 24	do	do	1.4	.7	.90		.6
Mar. 21	Crab Creek	3½ miles west of Odessa	24	125	3.29		410
Mar. 21	do	Odessa	34	126	3.21		403
Mar. 23	do	Railway bridge east of Stratford.	84	317	2.08		661
Aug. 16	do	Krupp	18	12.7	.66		8.4
Mar. 22	East Channel Crab Creek.	Blithe's ranch	8.7	10.4	3.46		36
Mar. 22	West Channel Crab Creek.	do				(a)	9.9
Mar. 30	Hangman Creek	Spokane	71	607	2.86	10.3	1,739
Oct. 21	Kettle River	Orient	108	1,185	.57	24.36	674
June 14	Pechastin Creek	Wenache	46	95	5.46		521
Sept. 16	Spokane River	Greenacres	254	1,181	.62		727
Mar. 19	Outlet Tule Lake	Tule Lake	6.1	27.1	1.72		46.7
June 14	Wenache River	Pechastin	237	1,542	6.35		10,830
June 16	do	Wenache		2,638	4.98		13,140
Sept. 21	Yakima River	Clealum	187	223	1.98		442
Sept. 23	do	Thorp	153	191	2.70		515
Mar. 19	Asotin Land and Water Co.'s canal.	Power plant, Asotin	1.8	.6	1.30		.8
Mar. 26	do	do	1.8	.6	1.27		.8
July 8	Clark canal	North Yakima		4.6	1.01		4.7
June 6	Kiona Water Supply Co.'s canal.	Kiona		14.1	1.31		18.5
Mar. 19	Lewiston Water Power Co.'s canal.	Above power pipe, Clarkson.	6	9	4.06	4.52	37
Mar. 26	do	do	6.2	11.3	2.63		30
July 1	do	do	5.8	11.3	3.76		43
July 1	do	Below power pipe, Clarkson	5.8	5.8	2.83		16.3
Aug. 5	Olsen canal	Ellensburg		11.6	1.23		14.3
June 30	Rhodenbach Schuler canal.	North Yakima		3.1	1.02		3.2
July 20	do	do		3.6	1.34		4.8
Aug. 9	Taylor canal	do		7.5	1.23		9.2
Sept. 19	do	do		14.3	.81		12.9
June 15	Wenache Canal Co.'s canal.	Pechastin	14	33	1.62		60
July 26	do	Cashmere	7	13.7	3.08		42
July 8	Lowry canal	North Yakima		11.9	1.21		14.5
July 2	Wide Hollow wasteway.	do		24	1.85		44
Aug. 1	do	do		28	1.01		28

a Weir.

PUGET SOUND DRAINAGE BASIN.

For convenience in arrangement, the smaller rivers which have their headwaters on the western slope of the Cascade Range and which flow into Puget Sound north of Seattle have been grouped as the Puget Sound drainage. Of these, White River has its source near Mount Rainier and flows into Puget Sound near Seattle, Wash. Cedar River is a tributary of Black River. Snoqualmie and Skykomish rivers unite to form the Snohomish, which flows into the Sound about 10 miles beyond the junction, near Everett, Wash. The Stilaguamish lies north of the Skykomish and has a parallel course. The results of the data collected in Puget Sound drainage basin are given on the following pages:

CEDAR RIVER NEAR RAVENSDALE, WASH.

This station is located at the intake of the Seattle waterworks and is 15 miles below Cedar Lake, 4 miles from the Northern Pacific Railway at Ravensdale and 6 miles from the Columbia and Puget Sound Railway at Maple Valley. The station was established September 27, 1902, by T. A. Noble. The gage is a plain staff graduated to feet and hundredths, to which is attached a hook gage and vernier reading to thousandths. When this gage reads zero the hook is level with the crest of the dam. It is fastened securely to the head gates above the dam, and is read daily by George Landsburg. The bench mark is the crest of the dam. The elevation, from city levels, of the south end is 535.831 feet and of the north end 535.840 feet. The gagings at this station are made at two points. The first is 142 feet below the dam, where the cross section is small, the current rapid, and suitable for gaging the stream at stages below 1 foot on the gage. The measurements at this point are made from a cable. The initial point for soundings is on the right bank. The channel is straight. The right bank is steep, the left bank has a sloping gravelly beach, and the bed of the stream is rocky. At all stages of the river above 1 foot on the gage the measurements are made from a cable located 600 feet above the dam, where the cross section is large and suitable for gaging the higher stages of the river. The initial point for soundings is a spike driven into the top of a hemlock stump about 12 inches in diameter near the edge of the water. The right bank is a sloping sandy beach; the left bank is steep and of hardpan formation. The bed is permanent—rocky near the right bank, and of sand and gravel near the left bank.

To the discharge measurements made below the dam should be added the amount of water flowing into the gravity system which supplies the city of Seattle. This varies from 34 to 37 second-feet. The discharge of this pipe line was measured during the winter of

1901–2 by T. A. Noble, and the results have been published in Volume XLIX, page 112, Transaction of the American Society of Civil Engineers.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Discharge measurement of Cedar River near Ravensdale, Wash., in 1904.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Ft. per sec.*	*Feet.*	*Sec.-feet.*
August 23	G. F. Harley	73	105	1.23	0.45	[a] 166

[a] Gaged below the dam; 36 second-feet added for city pipe.

Mean daily gage height, in feet, of Cedar River near Ravensdale, Wash., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.53	1.68	1.20	1.21	1.90	1.49	1.36	0.69	0.46	0.41	0.38	1.45
2	1.50	1.62	1.17	1.19	1.78	1.54	1.36	.58	.44	.40	.38	1.33
3	1.48	1.58	1.16	1.20	1.65	1.66	1.33	.52	.43	.40	.38	1.19
4	1.50	1.59	1.18	1.19	1.61	1.77	1.29	.53	.43	.40	.37	1.11
5	1.46	1.56	1.30	1.41	1.54	1.77	1.28	.50	.43	.41	.37	1.10
6	1.42	1.55	1.38	1.41	1.51	1.71	1.22	.51	.42	.40	.38	.90
7	1.40	1.59	1.61	1.37	1.60	1.63	1.24	.50	.43	.39	.43	.92
8	.90	1.44	1.65	1.34	1.56	1.49	1.22	.60	.45	.39	.42	.90
9	.94	1.39	1.21	1.36	1.54	1.35	1.19	.49	.47	.40	.41	.89
10	1.75	1.37	1.52	1.43	1.51	1.39	1.16	.49	.44	.39	.39	.88
11	1.66	1.33	1.49	1.41	1.51	1.36	1.19	.49	.43	.43	.37	.88
12	1.98	1.24	1.45	1.66	1.49	1.33	1.10	.49	.58	.41	.37	.92
13	2.18	1.29	1.43	1.77	1.48	1.33	1.07	.48	.58	.40	.37	1.04
14	2.38	1.28	1.40	1.81	1.50	1.36	1.06	.48	.55	.39	.37	1.33
15	2.66	1.28	1.38	1.81	1.49	1.40	1.04	.47	.45	.38	.38	2.15
16	2.54	1.26	1.36	1.93	1.49	1.67	1.01	.47	.42	.42	.40	2.10
17	2.33	1.24	1.34	1.94	1.49	1.55	.91	.46	.42	.44	.43	2.07
18	2.17	1.23	1.34	1.95	1.52	1.54	.90	.46	.41	.42	.54	1.96
19	1.96	1.20	1.32	1.99	1.69	1.54	.90	.45	.42	.41	.68	2.23
20	1.88	1.18	1.32	2.00	1.72	1.50	.90	.45	.60	.40	1.09	2.09
21	1.79	.91	1.28	2.22	1.66	1.49	.81	.44	.56	.39	1.48	1.97
22	1.91	1.06	1.26	2.20	1.75	1.48	.70	.45	.56	.38	1.29	1.90
23	1.89	1.37	1.24	2.06	1.80	1.49	.61	.45	.55	.38	.94	1.74
24	1.90	1.34	.89	1.93	1.79	1.48	.82	.44	.52	.38	.97	1.51
25	1.84	1.30	1.20	1.82	1.72	1.46	.81	.44	.49	.37	1.26	1.37
26	1.88	1.28	1.20	1.82	1.63	1.45	.79	.43	.46	.38	1.31	1.26
27	1.84	1.26	1.16	1.84	1.60	1.43	.77	.43	.44	.36	1.35	1.18
28	1.81	1.24	1.21	1.89	1.57	1.40	.78	.45	.42	.37	1.57	1.16
29	1.76	1.23	1.25	2.06	1.56	1.39	.76	.48	.41	.37	1.64	1.62
30	1.72	.....	1.26	2.01	1.57	1.38	.74	.45	.40	.38	1.53	1.75
31	1.68	.....	1.24	.....	1.57	.....	.72	.43	.....	.38	.....	1.67

Rating table for Cedar River near Ravensdale, Wash., from September 27, 1902, to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.4	177	1.4	795	2.4	1,640	3.8	3,300
.5	235	1.5	861	2.5	1,750	4.0	3,540
.6	294	1.6	927	2.6	1,860	4.2	3,780
.7	354	1.7	995	2.7	1,980	4.4	4,020
.8	414	1.8	1,065	2.8	2,100	4.6	4,260
.9	476	1.9	1,145	2.9	2,220	4.8	4,500
1.0	538	2.0	1,235	3.0	2,340	5.0	4,740
1.1	600	2.1	1,335	3.2	2,580	5.2	4,980
1.2	664	2.2	1,435	3.4	2,820	5.4	5,220
1.3	729	2.3	1,535	3.6	3,060	5.6	5,460

The above table is applicable for open-channel conditions only. It is based on 13 discharge measurements made during 1902–1904. It is fairly well defined to 2.70 feet gage height. The table has been extended above 2.7 feet. The rating table gives discharge at the upper section, above the intake of Seattle water-supply system.

Estimated monthly discharge of Cedar River near Ravensdale, Wash., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January	1,932	476	1,099	67,580
February	981	482	757	43,540
March	961	470	732	45,010
April	1,455	658	1,021	60,750
May	1,145	848	933	57,370
June	1,044	749	858	51,060
July	769	300	541	33,260
August	348	194	226	13,900
September	294	177	217	12,910
October	200	154	174	10,700
November	954	160	387	23,030
December	1,385	464	835	51,340
The year	1,932	154	648	470,400

SKYKOMISH RIVER (SOUTH FORK) NEAR INDEX, WASH.

This station was established October 6, 1902, by T. A. Noble. It is located about 2 miles above Index and about 300 feet from the railroad track. The gage is a plain staff graduated to feet and tenths. A hook gage is used for reading to hundredths of a foot. Readings are made daily by Louis G. Heybrook. The gage is fastened by means of plugs driven in drill holes in the solid rock. The bench

mark is a cross cut in the rock about 6 feet above low water and 40 feet downstream from the gage. Its elevation, as obtained from the Great Northern Railway, is 679.158 feet. The elevation of the zero of the gage is 669.926 feet. The initial point for soundings is on the left bank at a plug driven in the solid rock 10 feet from the edge of stream at low water. The gagings are made from a cable. The channel is straight for 500 feet above and 300 feet below the station. Both banks are of solid rock and are not liable to overflow. The bed of the stream is of sand and gravel, not liable to change except near the left bank, where the sand shifts at high water. This does not cause any important change in the cross section. This station is 300 feet upstream from Sunset Falls, where the river plunges down a solid granite ledge with a slope of about two horizontal to one vertical. The ledge answers the purpose of a spillway in regulating the flow of the river at the gaging station, since the water has a free discharge and a permanent bed just below the station.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Mean daily gage height, in feet, of Skykomish River (South Fork) near Index, Wash., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.05	2.60	2.05	2.45	5.90	6.55	7.00	2.85	1.20	1.30	1.40	5.30
2	2.20	2.50	1.95	2.80	5.40	6.70	6.50	2.85	1.20	1.10	1.65	4.55
3	2.80	2.65	2.00	2.80	5.40	7.90	6.65	2.60	1.15	1.00	1.90	4.00
4	3.20	2.70	1.90	2.85	5.45	7.35	6.10	2.60	1.30	.95	1.55	3.55
5	3.10	2.85	2.30	3.85	5.60	7.95	6.60	2.55	1.35	.90	1.40	3.30
6	3.00	2.85	4.20	4.60	4.90	8.00	6.35	2.50	1.40	.80	1.30	3.00
7	3.70	2.70	7.30	3.90	5.00	6.50	6.10	2.45	1.40	.70	2.25	2.85
8	4.40	2.50	7.30	3.50	4.60	5.80	5.60	2.40	1.40	.65	2.60	2.75
9	4.50	2.40	5.90	4.15	4.40	6.40	5.60	2.15	1.40	.60	1.95	2.50
10	4.10	2.20	5.75	5.80	4.60	6.00	5.65	2.00	1.65	.55	1.70	2.40
11	5.00	2.15	4.80	6.95	4.55	5.60	5.35	1.90	1.80	1.00	1.35	2.85
12	5.00	2.20	3.40	8.25	4.90	6.05	5.10	1.85	1.00	2.00	1.20	2.80
13	9.50	2.10	3.25	9.45	5.60	6.10	4.35	1.80	.95	1.20	1.15	3.30
14	10.60	2.00	3.15	9.60	6.55	7.30	3.90	1.85	.95	1.40	1.15	8.80
15	7.50	1.90	2.95	7.95	6.10	7.35	4.10	1.85	.90	.95	2.80	9.10
16	6.35	1.85	2.90	7.65	5.70	7.20	4.20	1.80	.90	1.35	3.20	7.30
17	5.85	1.90	2.90	6.85	5.95	6.70	4.85	1.75	.90	1.80	5.80	7.45
18	5.20	1.80	2.85	6.75	6.85	8.30	4.30	1.65	.90	1.45	4.40	8.20
19	5.55	1.90	2.70	6.90	6.55	7.10	3.85	1.65	.85	1.70	7.40	8.50
20	4.00	1.85	2.65	7.10	6.40	6.65	3.90	1.55	.80	1.50	9.25	6.15
21	3.85	2.40	2.60	7.20	7.25	6.50	3.95	1.50	.70	1.45	9.45	5.35
22	3.70	2.80	2.60	6.50	7.90	6.20	4.05	1.40	.90	1.40	10.60	4.40
23	3.35	3.35	2.35	5.90	7.50	5.65	3.75	1.35	.90	1.40	7.00	4.20
24	3.75	2.85	2.20	5.25	7.10	5.10	3.40	1.30	.85	1.25	5.35	3.75
25	2.45	2.55	2.10	5.20	6.45	5.20	3.25	1.25	.80	1.15	5.80	3.35
26	3.20	2.35	2.00	5.40	6.55	6.00	3.20	1.25	.80	1.05	6.15	3.15
27	3.60	2.40	1.95	7.30	6.95	6.40	3.35	1.20	.80	.95	7.20	2.90
28	2.90	2.25	1.95	8.10	7.35	6.80	3.05	1.40	.80	.90	7.60	3.20
29	2.75	2.20	2.30	8.90	7.10	7.00	3.00	1.60	2.10	.70	6.40	3.60
30	2.70	.....	2.70	6.60	7.05	7.45	2.60	1.40	1.50	1.00	6.30	4.40
31	2.60	.....	2.50	.....	6.50	.....	2.75	1.25	.....	1.80	.....	4.15

Rating table for Skykomish River (South Fork) near Index, Wash., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.40	340	1.90	810	3.40	1,550	5.60	3,045
.50	360	2.00	855	3.50	1,605	5.80	3,205
.60	385	2.10	900	3.60	1,660	6.00	3,375
.70	410	2.20	945	3.70	1,715	6.20	3,555
.80	435	2.30	990	3.80	1,775	6.40	3,740
.90	460	2.40	1,035	3.90	1,835	6.60	3,930
1.00	490	2.50	1,080	4.00	1,900	6.80	4,130
1.10	520	2.60	1,130	4.20	2,035	7.00	4,340
1.20	550	2.70	1,180	4.40	2,175	7.50	4,890
1.30	580	2.80	1,230	4.60	2,315	8.00	5,450
1.40	615	2.90	1,280	4.80	2,455	8.50	6,050
1.50	650	3.00	1,330	5.00	2,595	9.00	6,670
1.60	685	3.10	1,385	5.20	2,740	9.50	7,320
1.70	725	3.20	1,440	5.40	2,890	10.00	7,970
1.80	765	3.30	1,495				

The above table is applicable only for open-channel conditions. It is based upon 12 discharge measurements made during 1902 and 1903. It is well defined between gage heights 1.20 feet and 8.60 feet. The table has been extended beyond these limits. Above gage height 8.80 feet the rating curve is a tangent, the difference being 130 per tenth. This is a revision of the 1903 table.

Estimated monthly discharge of Skykomish River (South Fork) near Index, Wash., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January	8,750	945	2,321	142,700
February	1,522	765	1,027	59,070
March	4,670	810	1,530	94,080
April	7,450	1,058	3,682	219,100
May	5,330	2,175	3,518	216,300
June	5,810	2,665	4,047	240,800
July	4,340	1,058	2,382	146,500
August	1,255	550	805	49,500
September	900	410	532	31,660
October	855	372	553	34,000
November	8,750	535	2,552	151,900
December	6,800	1,035	2,525	155,300
The year	8,750	372	2,123	1,541,000

SNOQUALMIE RIVER NEAR SNOQUALMIE FALLS, WASH.

This station was originally established by T. A. Noble on September 14, 1902. The gage was then located below the falls, but was destroyed by the flood of December 1, 1902. On November 2 another gage was placed about 3 miles above Snoqualmie Falls post-office. The gage consisted of a plain staff graduated to feet and tenths, and reading to hundredths of a foot by means of a hook gage. The elevation of the zero on the gage was assumed to be 100.00 feet. The gage was fastened to an alder tree. January 3, 1903, this gage was washed out and on January 7 was replaced by a gage in two parts, 7 and 8 feet long, respectively. The elevation of the zero of the gage is 100.06 feet. The bench mark is on a large maple stump on the right bank. It consists of a spike driven into the stump about 4 feet from the ground. Its elevation is 127.89, or 27.83 feet above the zero of the gage. This is also the initial point for the soundings. The right bank is high and never overflows; the left bank overflows at extreme high water. The bed of the stream is of gravel and sand and is not liable to shift. The station is located below the junction of the north, south, and middle forks of the Snoqualmie River. At Snoqualmie Falls, about 4 miles below this station, the river flows over a precipice 268 feet high. Above the falls the Snoqualmie Falls Power Company has built a dam and water-power plant. The slack water from this dam reaches back from the falls about 3 miles and probably affects the flow of the river slightly at the gaging station. This is the only possible location for a gaging station which will include all three forks of the river.

On August 14, 1902, the dam below the station was raised 4 feet, backing up the water on the gage. This affected the gage height from August 14 to October 5, 1903, at which time the dam was washed out.

The observations at this station during 1904 have been made under the direction of T. A. Noble, district engineer.

Mean daily gage height, in feet, of Snoqualmie River near Snoqualmie Falls, Wash., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.40	2.80	2.40	3.20	4.70	5.20	5.60	1.95	1.00	1.10	1.60	4.30
2	3.40	2.60	2.25	3.20	4.40	5.00	5.65	1.90	.95	1.00	1.60	4.05
3	3.15	2.55	2.30	3.15	4.40	5.15	5.25	1.85	.80	.90	1.65	3.60
4	3.55	2.75	2.55	3.10	4.45	5.50	4.65	1.75	.80	.80	1.80	3.25
5	3.20	3.15	3.45	3.70	4.30	6.00	4.30	1.65	.80	.70	1.55	2.70
6	3.10	3.10	5.20	5.25	4.10	6.25	4.10	1.65	.80	.65	1.60	2.70
7	4.00	2.90	8.30	4.00	4.00	5.70	4.00	1.65	.80	.60	1.75	2.50
8	4.70	2.75	6.80	4.20	3.95	4.35	3.70	1.60	.90	.55	2.10	2.50
9	4.60	2.60	5.30	4.30	3.65	4.35	3.65	1.50	1.00	.65	2.00	2.60
10	4.35	2.35	4.55	4.90	3.70	4.55	3.60	1.40	1.00	.70	1.70	3.35
11	4.30	2.35	4.05	5.00	3.85	4.75	3.20	1.30	.90	.80	1.45	3.15
12	10.65	2.40	3.70	8.45	4.20	4.80	2.80	1.20	.80	1.75	1.35	2.85
13	10.75	2.40	3.45	9.80	4.90	5.25	2.70	1.20	.75	1.70	1.40	2.90
14	12.45	2.35	3.30	9.50	5.75	5.40	2.70	1.20	.75	1.30	1.20	4.60
15	5.65	2.30	3.05	8.50	5.20	5.35	2.70	1.20	.70	1.05	1.50	10.30
16	6.40	2.35	2.90	7.30	4.45	5.40	3.25	1.20	.65	1.75	3.00	6.95
17	5.95	2.20	2.90	6.05	4.75	6.40	3.20	1.15	.60	2.70	4.20	6.35
18	5.15	2.15	2.85	5.85	5.00	6.45	2.90	1.10	.60	2.00	3.90	5.25
19	4.25	2.10	2.90	5.10	5.85	6.10	2.80	1.10	.60	1.95	3.50	5.25
20	4.00	2.10	2.90	6.20	5.50	6.25	2.80	1.05	.60	1.90	12.80	5.20
21	4.00	2.10	2.70	6.90	6.20	5.40	2.80	1.00	.55	1.85	10.20	5.20
22	4.10	4.50	2.60	6.00	6.10	5.00	2.80	.95	.60	1.80	9.55	4.70
23	4.15	4.10	2.45	5.20	6.00	4.55	2.75	.90	.65	1.45	6.45	4.10
24	3.90	3.45	2.30	4.65	5.60	3.90	2.65	.90	.60	1.30	6.55	3.60
25	3.80	3.10	2.20	4.50	5.00	4.00	2.40	.85	.60	1.20	6.80	3.30
26	3.50	2.80	2.10	4.55	5.15	4.40	2.30	.85	.55	1.05	6.05	3.15
27	3.30	2.70	2.05	5.40	5.70	4.85	2.20	.85	.50	.90	6.70	3.25
28	3.10	2.60	2.60	6.65	5.70	5.10	2.05	.95	.70	.90	6.30	5.35
29	3.00	2.55	3.35	7.00	5.60	5.35	2.00	1.10	1.60	.85	5.65	7.15
30	2.85	.....	3.30	6.00	5.60	5.60	1.90	1.05	1.50	1.00	4.60	6.20
31	2.75	.....	3.25	.....	5.45	.....	1.90	1.00	.....	1.55	.....	4.75

Rating table for Snoqualmie River near Snoqualmie Falls, Wash., from January 1 to December 31, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.50	570	2.40	1,200	4.30	2,595	7.40	6,330
.60	590	2.50	1,250	4.40	2,690	7.60	6,610
.70	610	2.60	1,300	4.50	2,790	7.80	6,890
.80	630	2.70	1,360	4.60	2,890	8.00	7,170
.90	660	2.80	1,420	4.70	2,990	8.50	7,870
1.00	670	2.90	1,480	4.80	3,090	9.00	8,570
1.10	690	3.00	1,540	4.90	3,190	9.50	9,270
1.20	710	3.10	1,610	5.00	3,290	10.00	9,970
1.30	730	3.20	1,680	5.20	3,510	10.50	10,670
1.40	760	3.30	1,750	5.40	3,730	11.00	11,370
1.50	790	3.40	1,830	5.60	3,970	12.00	12,770
1.60	830	3.50	1,910	5.80	4,210	13.00	14,170
1.70	870	3.60	1,990	6.00	4,450	14.00	15,570
1.80	910	3.70	2,070	6.20	4,710	15.00	16,970
1.90	950	3.80	2,150	6.40	4,970	16.00	18,370
2.00	1,000	3.90	2,235	6.60	5,230	17.00	19,770
2.10	1,050	4.00	2,325	6.80	5,490	18.00	21,170
2.20	1,100	4.10	2,415	7.00	5,770	19.00	22,570
2.30	1,150	4.20	2,505	7.20	6,050	20.00	23,970

The above table is applicable only for open-channel conditions. It is based upon discharge measurements made during 1902–1903. It is well defined to gage height 8.70 feet. Above gage height 6.80 feet the rating curve is a tangent, the difference being 140 per tenth.

Estimated monthly discharge of Snoqualmie River near Snoqualmie Falls, Wash., for 1904.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January	13,400	1,390	3,298	202,300
February	2,790	1,050	1,394	80,180
March	7,590	1,025	1,961	120,600
April	9,690	1,610	4,215	250,800
May	4,710	2,030	3,288	202,200
June	4,970	2,235	3,567	212,200
July	4,030	950	1,799	110,600
August	975	640	741	45,600
September	830	570	620	37,500
October	1,360	580	754	46,400
November	13,890	710	3,055	181,800
December	10,390	1,250	2,887	177,500
The year	13,890	570	2,299	1,668,000

MISCELLANEOUS MEASUREMENTS IN PUGET SOUND DRAINAGE BASIN.

The following miscellaneous discharge measurements were made in the Puget Sound drainage basin in 1901 and 1903 by J. H. Cunningham, C. E., of Portland, Oreg.:

Miscellaneous measurements in Puget Sound drainage basin.

Date.	Stream.	Locality.	Gage height.	Discharge.
			Feet.	*Sec.-feet.*
Aug. 23, 1901	Green River	Kanasket, Wash		350
Sept. 1, 1901	do	do		238
Sept. 7, 1901	do	do		196
Oct. 8, 1901	do	do	0.0	179
July 21, 1901	Nesqually River	1 mile above Elbe, Wash		773
Oct. 4, 1901	do	do	.0	352
Sept. 19, 1901	do	Highway bridge near Yelm Prairie, Wash.		565
Oct. 7, 1901	do	do	.0	483
Sept. 15, 1901	Puyallup River	Puget Sound Power Co.'s gaging station, Wash.	.8	304
Jan. 18, 1903	do	do	.0	250
Feb. 23, 1903	do	do	8.0	9,560
July 28, 1901	Skykomish River	2 miles above Index, Wash		2,047
Aug. 26, 1901	do	do		942
Sept. 17, 1901	do	do	.0	606
Oct. 6, 1901	White River	Buckley, Wash		517

INDEX.

A.

Abiqua Creek, Oreg.
discharge 274
Alder Creek, Idaho.
discharge 271
American River near—
Niles, Wash.:
discharge 275
Antelope Creek, Idaho.
discharge 272
Asotin, Wash.
Asotin Creek near:
description 237–238, 239
discharge 238, 239
gage heights 238–239, 240
Asotin Land and Water Company's canal at:
discharge 275
Asotin Creek near—
Asotin, Wash.:
description 237–238, 239
discharge 238, 239
gage heights 238–239, 240
Asotin Land and Water Company's canal at—
Asotin, Wash.:
discharge 275
Aster Creek, Idaho.
discharge 270
Atanum Creek near—
North Yakima, Wash.:
description 105–106
discharge 106
discharge, monthly 107
gage heights 106
rating table 107

B.

Baker City, Oreg.
Powder River near:
description 221
discharge 222
discharge, monthly 223
gage heights 222
rating table 223
Bear or Little Spring, Idaho.
discharge 273
Bend, Oreg.
Deschutes River near:
description 269
discharge 269
gage heights 269

Page

Big Blackfoot River near—
Bonner, Mont.:
description 32
discharge 33
discharge, monthly 34
gage heights 33
rating table 34
Big Lost River near—
Mackay, Idaho:
description 187–188
discharge 188
discharge, monthly 189
gage heights 188
rating table 189
Chilly, Idaho:
description 190
discharge 190
discharge, monthly 192
gage heights 191
rating table 191
Big Payette River at—
Big Payette Lake, Idaho, outlet:
discharge 270
Big Spring, Idaho.
discharge 273
Big Wood River near—
Gimlet, Idaho:
description 192
discharge 193
gage heights 193
Bitterroot River near—
Grantsdale, Mont.:
description 35
discharge 35
discharge, monthly 37
gage heights 36
rating table 36
Missoula, Mont.:
description 37–38
discharge 38
discharge, monthly 40
gage heights 38–39
rating table 39
Blackfoot River near—
Presto, Idaho:
description 186
discharge 186
gage heights 187
Blue Springs, Idaho.
discharge 272
Boise, Idaho.
Boise River near:
description 199–200
discharge 201

Page.

Boise, Idaho—Continued.
Boise River near—Cont'd.
discharge, monthly 202
gage heights 201
rating table 202
Boise River near—
Boise, Idaho:
description 199–200
discharge 201
discharge, monthly 202
gage heights 201
rating table 202
Bonner, Mont.
Big Blackfoot River near:
description 32
discharge 33
discharge, monthly 34
gage heights 33
rating table 34
Bonners Ferry, Idaho.
Kootenai River near:
description 25–27
discharge 27
gage heights 27
Broadgauge canal near—
North Yakima, Wash.:
description 154
discharge 154
discharge, mean daily 155
discharge, monthly 155
gage heights 155
Buckley, Wash.
White River at:
discharge 284
Bully Creek at and near—
Vale, Oreg.:
description 211–212, 213
discharge 212, 214
discharge, monthly 215
gage heights 213, 214
Westfall, Oreg.:
discharge 274
Bumping River at—
Bumping Lake, Wash.:
discharge 275

C.

Cabin Creek, Idaho.
discharge 271
Cabin Creek near—
Easton, Wash.:
discharge 275
Caldwell Spring No. 1, Idaho.
discharge 272
Caldwell Spring No. 2, Idaho.
discharge 272
Canals in—
Yakima River Valley, Wash. 107–169
Canals taking water from—
Yakima, Tieton, and Naches rivers 165–169
Canyon Creek, Idaho.
discharge 273

Page.

Carey, Idaho.
Little Wood River near:
description 193–194
discharge 194
gage heights 194–195
Cascade canal near—
Thorp, Wash.:
description 109
Cashmere, Wash.
Wenache Canal Company's canal at:
discharge 275
Wenache River at:
description 71–72
discharge 72
gage heights 72
Cedar River near—
Ravensdale, Wash.:
description 276–277
discharge 277
discharge, monthly 278
gage heights 277
rating table 278
Chelan River below—
Lake Chelan, Wash.:
description 68–69
discharge 69
discharge, monthly 71
gage heights 69–70
rating table 70
Chilly, Idaho.
Big Lost River near:
description 190
discharge 190
discharge, monthly 192
gage heights 191
rating table 191
Clark canal in—
Yakima River Valley, Wash.:
data concerning 146, 167–169, 275
Clark Fork at—
Priest River, Idaho:
description 40–41
discharge 41
discharge, monthly 43
gage heights 41–42
rating table 42
Clarkson, Wash.
Lewiston Water Power Company's canal at:
discharge 275
Clealum, Wash.
Yakima River at—
discharge 275
Clealum River near—
Lake Clealum, Wash.:
discharge 275
Roslyn, Wash.:
description 92–93
discharge 93
discharge, monthly 95
gage heights 93–94
rating table 94
Clearwater River, Idaho.
discharge 270

Page.

Cobb and Sinclair canal. *See* Sinclair and Cobb canal.
Columbia River near—
Pasco, Wash.:
description 24
discharge 25
gage heights 25
Columbia River drainage basin.
description 21–24
miscellaneous measurements 270–275
Colville River at—
Kettle Falls, Wash.:
discharge 275
Conant Creek, Idaho.
discharge 270
Coolie Creek, Idaho.
discharge 273
Cottonwood Creek at—
Rock Lake, Wash.:
discharge 275
Cow Creek at and near—
Hooper, Wash.:
description 251
discharge 251
Keystone, Wash.:
description 250
discharge 250
gage heights 250
Cox canal in—
Yakima River Valley, Wash.:
data concerning 146, 167–169
Crab Creek at and near—
Wilson Creek, Wash.:
description 73
discharge 73
gage heights 73
Odessa, Wash.:
discharge 275
Krupp, Wash.:
discharge 275
Stratford, Wash.:
discharge 275
Crescent Creek, Oreg.
above Deschutes River:
discharge 274
at outlet Crescent Lake:
discharge 274
Crossport, Idaho.
Kootenai River at:
gage heights 28

D.

Davis Creek, Oreg.
discharge 274
Deer Creek, Idaho.
discharge 271
Dell, Oreg.
Willow Creek near:
description 216–217
discharge 217
discharge, monthly 218
gage heights 217
rating table 218

Page.

Deschutes River, Oregon.
miscellaneous measurements of 274
near Bend, Oreg.:
description 269
discharge 269
gage heights 269
Deschutes River (East Fork) at—
Odell, Oreg.:
description 269–270
gage heights 270
Deschutes River (West Branch), Oreg.
at Odell, Oreg.:
discharge 274
at Rosland, Oreg.:
discharge 274
Dry Hollow Creek, Idaho.
discharge 271
Duck Creek, Idaho.
discharge 273

E.

East Bald Cabin Springs, Idaho.
discharge 272
Easton, Wash.
Cabin Creek near:
discharge 275
Kachess River near:
description 90
discharge 90
discharge, monthly 92
gage heights 91
rating table 91
Yakima River at:
description 76–77
discharge 77
discharge, monthly 79
gage heights 77–78
rating table 78
Edwards Creek, Idaho.
discharge 271
Elbe, Wash.
Nesqually River near:
discharge 284
Elberton, Wash.
Palouse River at:
description 240–241
discharge 241
discharge, monthly 243
gage heights 241–242
rating table 242
Elgin, Oreg.
Grande Ronde River at:
description 226–227
discharge 227
discharge, monthly 229
gage heights 227–228
rating table 228
Wallowa River near:
description 235
discharge 235
discharge, monthly 237
gage heights 236
rating table 236

Page.

Elk Creek near—
Rosa, Idaho:
discharge 271
Ellensburg, Wash.
Olsen (or Mill) ditch near:
description 113
discharge 275
Town canal near:
description 111
discharge 112
discharge, mean daily 112
discharge, monthly 113
gage heights 112

F.

Fall Creek, Idaho.
discharge 271
Fall River at—
Fremont, Idaho:
description 175–176
discharge 176
gage heights 176
Fish Creek, Idaho.
discharge 270
Fortune canal in—
Yakima River Valley, Wash.:
data concerning 146, 167–169
Fowler canal near—
North Yakima, Wash.:
description 120
discharge 120
discharge, mean daily 121
discharge, monthly 122
gage heights 120
rating table 121
Fremont, Idaho.
Fall River at:
description 175–176
discharge 176
gage heights 176

G.

Garden Creek, Idaho.
discharge 272
Garner Spring, Idaho.
discharge 273
Gibbon, Oreg.
Umatilla River at:
description 256–257
discharge 257
gage heights 257–258
Gilbert canal near—
Toppenish, Wash.:
description 130
discharge 131
discharge, mean daily 131, 132
discharge, monthly 133
gage heights 131, 132
Gimlet, Idaho.
Big Wood River near:
description 192
discharge 193
gage heights 193

Page.

Gleed canal near—
North Yakima, Wash.:
description 147
discharge 147
discharge, mean daily 148
discharge, monthly 149
gage heights 147
rating table 148
Golf Spring, Idaho.
discharge 273
Government canal No. 3 near—
Toppenish, Wash.:
description 127
Grande Ronde River at—
Elgin, Oreg.:
description 226–227
discharge 227
discharge, monthly 229
gage heights 227–228
rating table 228
Hilgard, Oreg.:
description 224
discharge 225
discharge, monthly 226
gage heights 225
rating table 226
Zindel, Wash.:
description 229
discharge 230
gage heights 230
Granger canal near—
North Yakima, Wash.:
description 122
discharge 122
gage heights 122–123
Granite Creek, Idaho.
discharge 272
Grantsdale, Mont.
Bitterroot River near:
description 35
discharge 35
discharge, monthly 37
gage heights 36
rating table 36
New Hedge ditch near:
discharge 274
Republican ditch near:
discharge 274
Green River at—
Kanasket, Wash.:
discharge 284
Green Springs, Idaho.
discharge 272
Greenacres, Wash.
Spokane River at:
discharge 275
Grizzly Spring, Idaho.
discharge 272
Grosscup's canal near—
Kiona, Wash.:
description 141

H. Page.

Hangman Creek at—
Poole's ranch, near Tekoa, Wash.:
description 54
gage heights 55
Spokane, Wash.:
discharge 275
Tekoa, Wash.:
description 51–52
discharge 52
discharge, monthly 54
gage heights 52–53
rating table 53
Hangman Creek (North Fork) at—
Tekoa, Wash.:
description 55–56
discharge 56
discharge, monthly 57
gage heights 56
rating table 57
Hatch canal near—
Toppenish, Wash.:
description 133
discharge 133
Hawley Springs below—
Heise, Idaho:
discharge 271
Henry Fork (of North Fork Snake River), Idaho, tributaries of:
miscellaneous measurements of 273
Henry Lake, Idaho, tributaries of:
miscellaneous measurement of 273
Hilgard, Oreg.
Grande Ronde River at:
description 224
discharge 225
discharge, monthly 226
gage heights 225
rating table 226
Hill Creek, Idaho.
discharge 272
Homedale, Idaho.
Succor Creek near:
description 195–196
discharge 196
gage heights 196
Hooper, Wash.
Cow Creek at:
description 251
discharge 251
Palouse River at:
description 243–244
discharge 245
discharge, monthly 247
gage heights 245–246
rating table 246
Hope Creek, Idaho.
discharge 273
Howe Creek, Idaho.
discharge 273

Page.

Howard Creek, Idaho.
discharge 273
Hubbard canal near—
North Yakima, Wash:
description 116
discharge 118
discharge, mean daily 119
discharge, monthly 119
gage heights 118
rating table 119

I.

Ice House Creek, Idaho.
discharge 272
Idaho.
miscellaneous measurements in 270–273
Index, Wash.
Skykomish River near:
discharge 284
Skykomish River (South Fork) near:
description 278–279
discharge, monthly 280
gage heights 279
rating table 280
Indian Creek, Idaho.
discharge 271

J.

Jessie Creek, Idaho.
discharge 273
John Day River at-
McDonald, Oreg.:
description 268
discharge 268
gage heights 268
Johnson Creek, Idaho.
discharge 273
Johnson Creek near—
Riverside, Wash.:
description 61–62
discharge, monthly 63
gage heights 62
rating table 62
Joseph, Oreg.
Wallowa River near:
description 230–231
discharge 231
discharge, monthly 232
gage heights 231
rating table 232

K.

Kachess River near—
Easton, Wash.:
description 90
discharge 90
discharge, monthly 92
gage heights 91
rating table 91

Page.

Kanasket, Wash.
Green River at:
discharge 284
Kelly canal in—
Yakima River Valley, Wash.:
data concerning 146, 167–169
Kelly Creek above—
Heise, Idaho:
discharge 271
Kennewick, Wash.
Kennewick canal near:
description 138
discharge 139
discharge, mean daily 140
discharge, monthly 140
gage heights 139
Kennewick canal near—
Kennewick, Wash.:
description 138
discharge 139
discharge, mean daily 140
discharge, monthly 140
gage heights 139
Kettle River at—
Orient, Wash.:
discharge 275
Keystone, Wash.
Cow Creek near:
description 250
discharge 250
gage heights 250
Kiona, Wash.
Grosscup's canal near:
description 141
Kiona canal near:
description 136
discharge 137
discharge, mean daily 137
discharge, monthly 138
gage heights 137
Kiona Water Supply Company's canal near:
description 138
discharge 275
Yakima River at:
description 87–88
discharge 88
discharge, monthly 89
gage heights 88
rating table 89
Kiona canal near—
Kiona, Wash.:
description 136
discharge 137
discharge, mean daily 137
discharge, monthly 138
gage heights 137
Kiona Water Supply Company's canal near—
Kiona, Wash.:
description 138
discharge 275
Kootenai River at and near—
Bonners Ferry, Idaho:
description 25–27
discharge 27
gage heights 27

Page

Kootenai River at and near—
Crossport, Idaho:
gage heights 28
Porthill, Idaho:
gage heights 28

L.

Lake Chelan, Wash.
Chelan River below:
description 68–69
discharge 69
discharge, monthly 71
gage heights 69–70
rating table 70
Laswell canal in—
Yakima River Valley, Wash.:
data concerning 146, 167–169
Leach and White ditch. *See* White and Leach ditch.
Ledbetter canal near—
Prosser, Wash.:
description 136
Lewis Lake outlet, Idaho.
discharge 270
Lewiston Water Power Company's canal at—
Clarkson, Wash.:
discharge 275
Little Pine Creek, Idaho.
discharge 272
Little Spokane River near—
Spokane, Wash.:
description 57–58
discharge 58
gage heights 58–59
Little Spring. *See* Bear Spring.
Little Wood River near—
Carey, Idaho:
description 193–194
discharge 194
gage heights 194–195
Loomis, Wash.
Siniahekin Creek near:
description 59
discharge, monthly 61
gage heights 60
rating table 60
Lower Scott canal in—
Yakima River Valley, Wash.:
data concerning 146, 167–169
Lowry canal in—
Yakima River Valley, Wash.:
data concerning 146
167–169, 275
Lyman, or Lyon, Creek above—
Sunnydell, Idaho:
discharge 271
Lyon, Idaho.
Snake River (South Fork) near:
description 182
discharge 183
discharge, monthly 184
gage heights 183
rating table 184

M. Page.

McCormick ditch in—
Yakima River Valley, Wash.:
data concerning 146, 167–169
McDonald, Oreg.
John Day River at:
description 268
discharge 268
gage heights 268
McKay Creek near—
Pendleton, Oreg.:
description 266–267
discharge 267
gage heights 267
Mackay, Idaho.
Big Lost River near:
description 187–188
discharge 188
discharge, monthly 189
gage heights 188
rating table 189
Malheur, Oreg.
Willow Creek near:
description 215
discharge 216
gage heights 216
Malheur River at and near—
Ontario, Oreg.:
description 209, 210–211
discharge 210, 211
gage heights 210, 211
Vale, Oreg.:
description 206, 209
discharge 207
discharge, monthly 208
gage heights 207
rating table 208
Westfall, Oreg.:
description 203
discharge 204
discharge, monthly 205
gage heights 204
rating table 205
Malott, Wash.
Salmon Creek near:
description 63
discharge 64
discharge, monthly 65
gage heights 64
rating table 65
Martin, Wash.
Yakima River near:
description 74
discharge 75
discharge, monthly 76
gage heights 75
rating table 76
Marysville, Idaho.
tributaries of Snake River (North Fork) above:
miscellaneous measurements of 272
Meadow Creek, Idaho.
discharge 273

Page.

Methow River near—
Pateros, Wash.:
description 65–66
discharge 66
discharge, monthly 68
gage heights 67
rating table 67
Mill ditch. *See* Olsen ditch.
Milton, Oreg.
Walla Walla River at:
description 254
discharge 254
discharge, monthly 256
gage heights 255
rating table 255
Walla Walla River (South Fork) near:
description 251–252
discharge 252
discharge, monthly 253
gage heights 252–253
rating table 253
Minidoka, Idaho.
Snake River near:
description 172–173
discharge 173
discharge, monthly 175
gage heights 173–174
rating table 174
Missoula, Mont.
Bitterroot River near:
description 37–38
discharge 38
discharge, monthly 40
gage heights 38–39
rating table 39
Missoula River at:
description 28–29
discharge 29
discharge, monthly 31
gage heights 30
rating table 31
Rattlesnake Creek at:
discharge 274
Missoula River at—
Missoula, Mont.:
description 28–29
discharge 29
discharge, monthly 31
gage heights 30
rating table 31
Missoula River basin, Mont.
miscellaneous measurements in 274
Molalla River, Oreg.
discharge 274
Montana:
miscellaneous measurements in 274
Moran, Wyo.
Snake River (South Fork) at:
description 179–180
discharge 180

Page.

Moran, Wyo.—Continued.
Snake River (South Fork) at—Continued.
discharge, monthly ---- 181
gage heights ---- 180
rating table ---- 181
Morrissey ditch in—
Yakima River Valley, Wash.:
data concerning ---- 146, 167–169
Moxee canal near—
North Yakima, Wash.:
description ---- 116
discharge ---- 116
discharge, mean daily ---- 117
discharge, monthly ---- 119
gage heights ---- 116–117

N.

Naches River near—
Nile, Wash.:
description ---- 95–96
discharge ---- 96
discharge, monthly ---- 97
gage heights ---- 96–97
rating table ---- 97
North Yakima, Wash.:
description ---- 98–100
discharge ---- 101
discharge, monthly ---- 102
gage heights ---- 101
rating table ---- 102
Naches and Tieton rivers, Wash.
canals taking water from ---- 167–169
Naches-Cowiche canal near—
North Yakima, Wash.:
description ---- 152
discharge ---- 152
discharge, mean daily ---- 153
discharge, monthly ---- 154
gage heights ---- 152
rating table ---- 153
Nesqually River near—
Elbe, Wash.:
discharge ---- 284
Yelm Prairie, Wash.:
discharge ---- 284
New Hedge ditch near—
Grantsdale, Mont.:
discharge ---- 274
New Reservation canal No. 2 in—
Yakima Indian Reservation, Wash.:
description ---- 123
discharge ---- 123
discharge, mean daily ---- 124
discharge, monthly ---- 125
gage heights ---- 124
rating table ---- 125
Nile, Wash.
Naches River near:
description ---- 95–96
discharge ---- 96
discharge, monthly ---- 97
gage heights ---- 96–97
rating table ---- 97

Page.

North Yakima, Wash.
Atanum Creek near:
description ---- 105–106
discharge ---- 106
discharge, monthly ---- 107
gage heights ---- 106
rating table ---- 107
Broadgauge canal near:
description ---- 154
discharge ---- 154
discharge, mean daily ---- 155
discharge, monthly ---- 155
gage heights ---- 155
Clark canal at:
discharge ---- 275
Fowler canal near:
description ---- 120
discharge ---- 120
discharge, mean daily ---- 121
discharge, monthly ---- 122
gage heights ---- 120
rating table ---- 121
Granger canal near:
description ---- 122
discharge ---- 122
gage heights ---- 122–123
Gleed canal near:
description ---- 147
discharge ---- 147
discharge, mean daily ---- 148
discharge, monthly ---- 149
gage heights ---- 147
rating table ---- 148
Hubbard canal near:
description ---- 116
discharge ---- 118
discharge, mean daily ---- 119
discharge, monthly ---- 119
gage heights ---- 118
rating table ---- 119
Lowry canal at:
discharge ---- 275
Moxee canal near:
description ---- 116
discharge ---- 116
discharge, mean daily ---- 117
discharge, monthly ---- 119
gage heights ---- 116–117
Naches River near:
description ---- 98–100
discharge ---- 101
discharge, monthly ---- 102
gage heights ---- 101
rating table ---- 102
Naches-Cowiche canal near:
description ---- 152
discharge ---- 152
discharge, mean daily ---- 153
discharge, monthly ---- 154
gage heights ---- 152
rating table ---- 153
Power canal at:
description ---- 156
discharge ---- 156
discharge, mean daily ---- 157

Page.

North Yakima, Wash.—Continued.
Power canal at—Continued.
discharge, monthly 158
gage heights 156–157
Rhodenbach Schuler canal at:
discharge 275
Selah Valley canal near:
description 141
discharge 141
discharge, mean daily 142–143
discharge, monthly 144
gage heights 142
rating table 143
Selah-Moxee canal near:
description 113
discharge 113
discharge, mean daily 114–115
discharge, monthly 115
gage heights 114
rating table 115
Shanno canal at:
description 158
discharge 158
discharge, mean daily 159
discharge, monthly 160
gage heights 159
rating table 159
Sinclair and Cobb canal near:
description 141
Taylor canal near:
description 116
discharge 116, 275
Tieton River near:
description 103
discharge 103
discharge, monthly 105
gage heights 104
rating table 104
Town canal at:
description 163
discharge 163
discharge, mean daily 164
discharge, monthly 165
gage heights 163–164
Union canal at:
description 160
discharge 161, 162
discharge, mean daily 161, 162
discharge, monthly 163
gage heights 161, 162
Wapatox canal near:
description 144
discharge 144
discharge, mean daily 145–146
discharge, monthly 146
gage heights 145
Wide Hollow waterway at:
discharge 275
Yakima River near:
description 79
discharge 80
discharge, monthly 81
gage heights 80
rating table 81

Page.

North Yakima, Wash.—Continued.
Yakima Valley canal near:
description 149
discharge 149
discharge, mean daily 150–151
discharge, monthly 151
gage heights 149–150
rating table 151
Northwestern Light and Water Company's proposed canal in—
Yakima River Valley, Wash.:
description 165

O.

Odell, Oreg.
Deschutes River (East Fork) at:
description 269–270
gage heights 270
Deschutes River (West Branch) at:
discharge 274
Old Reservation canal No. 1 in—
Yakima Indian Reservation, Wash.:
description 125
discharge 126
discharge, mean daily 126
discharge, monthly 127
gage heights 126
Olsen (or Mill) ditch near—
Ellensburg, Wash.:
description 113
discharge 275
Ontario, Oreg.
Malheur River near:
description 209, 210–211
discharge 210, 211
gage heights 210, 211
Ora, Idaho.
Snake River (North Fork) near:
description 170
discharge 170
discharge, monthly 172
gage heights 171
rating table 171
Oregon, miscellaneous measurements in 274
Oregon Land and Water Company's ditch near—
Umatilla, Oreg.:
discharge 264
Orient, Wash.
Kettle River at:
discharge 275
Osborn Creek, Idaho.
discharge 272
Oswald Creek, Idaho.
discharge 273
Owyhee, Oreg.
Owyhee River near:
description 196–197
discharge 197

Page.

Owyhee, Oreg.—Continued.
Owyhee River near—Cont'd.
discharge, monthly ----- 199
gage heights ---------- 197–198
rating table ---------- 198
Owyhee ditch near:
discharge, monthly ----- 199
Owyhee ditch near—
Owyhee, Oreg.:
discharge, monthly ----- 199
Owyhee River near—
Owyhee, Oreg.:
description ---------- 196–197
discharge ---------- 197
discharge, monthly ----- 199
gage heights ---------- 197–198
rating table ---------- 198

P.

Palisade Creek, Idaho.
discharge ---------- 271
Palouse River at—
Elberton, Wash.:
description ---------- 240–241
discharge ---------- 241
discharge, monthly ----- 243
gage heights---------- 241–242
rating table ---------- 242
Hooper, Wash.:
description ---------- 243–244
discharge ---------- 245
discharge, monthly----- 247
gage heights---------- 245–246
rating table ---------- 246
Pasco, Wash.
Columbia River near:
description ---------- 24
discharge ---------- 25
gage heights---------- 25
Pateros, Wash.
Methow River near:
description ---------- 65–66
discharge ---------- 66
discharge, monthly----- 68
gage heights---------- 67
rating table ---------- 67
Pechastin, Wash.
Wenache Canal Company's canal at:
discharge ---------- 275
Wenache River at:
discharge ---------- 275
Pechastin Creek at—
Wenache, Wash.:
discharge ---------- 275
Pend Oreille River. *See* Clark Fork.
Pendleton, Oreg.
McKay Creek near:
description ---------- 266–267
discharge ---------- 267
gage heights---------- 267
Umatilla River at:
description ---------- 258–259

Page

Pendleton, Oreg.—Continued.
Umatilla River at—Cont'd.
discharge ---------- 259
gage heights---------- 260
Wildhorse Creek at:
discharge ---------- 274
Pine Creek, Idaho.
discharge ---------- 273
Poole's ranch, near Tekoa, Wash.
Hangman Creek at:
description ---------- 54
discharge ---------- 55
Porcupine Creek, Idaho.
discharge ---------- 271
Porthill, Idaho.
Kootenai River near:
gage heights---------- 28
Power canal at—
North Yakima, Wash.:
description ---------- 156
discharge ---------- 156
discharge, mean daily--- 157
discharge, monthly---- 158
gage heights---------- 156–157
Powder River near—
Baker City, Oreg.:
description ---------- 221
discharge ---------- 222
discharge, monthly----- 223
gage heights---------- 222
rating table ---------- 223
Presto, Idaho.
Blackfoot River near:
description ---------- 186
discharge ---------- 186
gage heights---------- 187
Priest River, Idaho.
Clark Fork at:
description ---------- 40–41
discharge ---------- 41
discharge, monthly ----- 43
gage heights---------- 41–42
rating table ---------- 42
Priest River at:
description ---------- 43–44
discharge ---------- 44
discharge, monthly ----- 46
gage heights---------- 44–45
rating table ---------- 45
Pritchard Creek, Idaho.
discharge ---------- 271
Prospect, Idaho.
Willow Creek near:
description ---------- 185
discharge ---------- 185
gage heights---------- 185–186
Prosser, Wash.
Ledbetter canal near:
description ---------- 136
Prosser Falls Irrigation Company's power canal at:
description ---------- 133–134
discharge---------- 134
discharge, mean daily--- 134
discharge, monthly----- 135

Page.

Prosser, Wash.—Continued.
Prosser Falls Irrigation Company's irrigating canal at:
discharge, mean daily 135
discharge, monthly 136
Yakima River at:
description 85
discharge 85
discharge, monthly 87
gage heights 86
rating table 86
Prosser Falls Irrigation Company's irrigating canal at:
Prosser Wash.:
discharge, mean daily 135
discharge, monthly 136
Prosser Falls Irrigation Company's power canal at—
Prosser Wash.:
description 133-134
discharge 134
discharge, mean daily 134
discharge, monthly 135
Puget Sound drainage basin.
description 276
miscellaneous measurements 284
Puyallup River, Wash.
discharge 284

R.

Rainy Creek, Idaho.
discharge 271
Rattlesnake Creek at—
Missoula, Mont.:
discharge 274
Ravensdale, Wash.
Cedar River near:
description 276-277
discharge 277
discharge, monthly 278
gage heights 277
rating table 278
Republican ditch near—
Grantsdale, Mont.:
discharge 274
Rhodenbach Schuler ditches in—
Yakima River Valley, Wash.:
data concerning 146, 167-169, 275
Riverside, Wash.
Johnson Creek near:
description 61-62
discharge, monthly 63
gage heights 62
rating table 62
Rock Creek, Idaho.
discharge 273
Rock Creek, Oreg.
discharge 274
Rock Creek near—
St. John, Wash.:
description 247-248
discharge 248

Page.

Rock Creek near—
St. John, Wash.—Continued.
discharge, monthly 249
gage heights 248
rating table 249
Rock Springs, Idaho.
discharge 273
Rogue River, Oreg.
discharge 274
Rosland, Oreg.
Deschutes River (West Branch at:
discharge 274
Roslyn, Wash.
Cleallum River near:
description 92-93
discharge 93
discharge, monthly 95
gage heights 93-94
rating table 94

S.

St. Anthony, Idaho.
Teton River near:
description 177
discharge 177
discharge, monthly 179
gage heights 178
rating table 178
St. John, Wash.
Rock Creek near:
description 247-248
discharge 248
discharge, monthly 249
gage heights 248
rating table 249
Salmon Creek near—
Malott, Wash.:
description 63
discharge 64
discharge, monthly 65
gage heights 64
rating table 65
Santiam River, Oreg.
discharge 274
Selah Valley canal near—
North Yakima, Wash.:
description 141
discharge 141
discharge, mean daily 142-143
discharge, monthly 144
gage heights 142
rating table 143
Selah-Moxee canal near—
North Yakima, Wash.:
description 113
discharge 113
discharge, mean daily 114-115
discharge, monthly 115
gage heights 114
rating table 115
Shanno canal at—
North Yakima, Wash.:
description 158
discharge 158
discharge, mean daily 159

Page.

Shanno canal at—
North Yakima, Wash.—Cont'd.
discharge, monthly 160
gage heights 159
rating table 159
Shearer and Chapman ditches in—
Yakima River Valley, Wash.:
data concerning 146, 167–169
Sheep Creek, Idaho.
discharge 271
Sherwood Springs, Idaho.
discharge 273
Shoshone Lake outlet, Idaho.
discharge 270
Shotgun Creek, Idaho.
discharge 272
Silver Creek, Oreg.
discharge 274
Sinclair and Cobb canal near—
North Yakima, Wash.:
description 141
Sinlahekin Creek near—
Loomis, Wash.:
description 59
discharge, monthly 61
gage heights 60
rating table 60
Skykomish River near—
Index, Wash.:
discharge 284
Skykomish River (South Fork) near—
Index, Wash.:
description 278–279
discharge, monthly 280
gage heights 279
rating table 280
Snake River near—
Minidoka, Idaho:
description 172–173
discharge 173
discharge, monthly 175
gage heights 173–174
rating table 174
Snake River (North Fork), Idaho.
discharge 270
near Ora, Idaho:
description 170
discharge 170
discharge, monthly 172
gage heights 171
rating table 171
tributaries of:
miscellaneous measurements of 272
Snake River (Henry Fork of North Fork).
discharge 270
Snake River (South Fork).
at Moran, Wyo.:
description 179–180
discharge 180
discharge, monthly 181
gage heights 180
rating table 181

Page.

Snake River (South Fork)—Cont'd.
tributaries of, in Idaho:
miscellaneous measurements of 271–272
near Lyon, Idaho:
description 182
discharge 183
discharge, monthly 184
gage heights 183
rating table 184
Snoqualmie Falls, Wash.
Snoqualmie River near:
description 281
discharge, monthly 284
gage heights 282
rating table 283
Snoqualmie River near—
Snoqualmie Falls, Wash.:
description 281
discharge, monthly 284
gage heights 282
rating table 283
Snow Water Creek, Idaho.
discharge 273
Sorenson Spring, Idaho.
discharge 272
Spokane, Wash.
Hangman Creek at:
discharge 275
Little Spokane River near:
description 57–58
discharge 58
gage heights 58–59
Spokane River at:
description 46–48
discharge 48
discharge, monthly 50–51
gage heights 49
rating table 50
Spokane River, Idaho.
discharge 270
Spokane River, Wash., at—
Greenacres, Wash.:
discharge 275
Spokane, Wash.:
description 46–48
discharge 48
discharge, monthly 50–51
gage heights 49
rating table 50
Squaw Creek, Idaho.
discharge 271
Succor Creek near—
Homedale, Idaho:
description 195–196
discharge 196
gage heights 196
Summit Creek, Idaho.
discharge 271
Sunnydell, Idaho.
Lyman, or Lyon, Creek above:
discharge 271
Sunnyside canal near—
Yakima, Wash.:
description 127–128
discharge 128

Page.
Sunnyside canal near—
Yakima, Wash.—Continued.
discharge, mean daily 129
discharge, monthly 130
gage heights 128–129
rating table 130

T.

Tahgee Creek, Idaho.
discharge 273
Taylor canal near—
North Yakima, Wash.:
description 116
discharge 116, 275
Taylor Creek, Idaho.
discharge 272
Tekoa, Wash.
Hangman Creek at and near:
description 51–52, 54
discharge 52
discharge, monthly 54
gage heights 52–53, 55
rating table 53
Hangman Creek (North Fork) at:
description 55–56
discharge 56
discharge 57
gage heights 56
rating table 57
Teton River near—
St. Anthony, Idaho:
description 177
discharge 177
discharge, monthly 179
gage heights 178
rating table 178
Thompson Springs, Idaho.
discharge 273
Thorp, Wash.
Cascade canal near:
description 109
West Kittitas canal near:
description 109
discharge 109
discharge, mean daily 111
discharge, monthly 111
gage heights 110
rating table 110
Yakima River at:
discharge 275
Thurman Creek, Idaho.
discharge 272
Thurman Springs, Idaho.
discharge 272
Tieton River near—
North Yakima, Wash.:
description 103
discharge 103
discharge, monthly 105
gage heights 104
rating table 104
Tieton and Naches rivers, Wash.
canals taking water from 167–169

Page.
Timber Creek, Idaho.
discharge 273
Tom Creek, Idaho.
discharge 272
Toppenish, Wash.
Gilbert canal near:
description 130
discharge 131
discharge, mean daily 131, 132
discharge, monthly 133
gage heights 131, 132
Government canal No. 3 near:
description 127
Hatch canal near:
description 133
discharge 133
Town canal at and near—
Ellensburg, Wash.:
description 111
discharge 112
discharge, mean daily 112
discharge, monthly 113
gage heights 112
North Yakima, Wash.:
description 163
discharge 163
discharge, mean daily 164
discharge, monthly 165
gage heights 163–164
Tule Lake outlet at—
Tule Lake, Wash.:
discharge 275
Twin Creek, Idaho.
discharge 273

U.

Umatilla, Oreg.
Oregon Land and Water Company's ditch near:
discharge 264
Umatilla River near:
description 263–264
discharge 264
discharge, monthly 266
gage heights 264–265
rating table 265
Umatilla River at and near—
Gibbon, Oreg.:
description 256–257
discharge 257
gage heights 257–258
Pendleton, Oreg.:
description 258–259
discharge 259
gage heights 260
Umatilla, Oreg.:
description 263–264
discharge 264
discharge, monthly 266
gage heights 264–265
rating table 265
Yoakum, Oreg.:
description 260–261
discharge 261

Page.

Umatilla River at and near—
Yoakum, Oreg.—Continued.
discharge, monthly ----- 263
gage heights ---------- 261-262
rating table ---------- 262
Union canal at—
North Yakima, Wash.:
description ---------- 160
discharge ---------- 161, 162
discharge, mean daily --- 161, 162
discharge, monthly ----- 163
gage heights ---------- 161, 162
Upper Scott canal in—
Yakima River Valley, Wash.:
data concerning ---- 146, 167-169

V.

Vale, Oreg.
Bully Creek at and near:
description --------- 211-212, 213
discharge ---------- 212, 214
discharge, monthly ----- 215
gage heights ---------- 213, 214
Malheur River at and near:
description ---------- 206, 209
discharge ---------- 207
discharge, monthly ----- 208
gage heights ---------- 207
rating table ---------- 208

W.

Walla Walla River at—
Milton, Oreg.:
description ---------- 254
discharge ---------- 254
discharge, monthly ----- 256
gage heights ---------- 255
rating table ---------- 255
Walla Walla River (South Fork) near—
Milton, Oreg.:
description ---------- 251-252
discharge ---------- 252
discharge, monthly ----- 253
gage heights ---------- 252-253
rating table ---------- 253
Wallowa, Oreg.
Wallowa River near:
description ---------- 232-233
discharge ---------- 233
discharge, monthly ----- 234
gage heights ---------- 233-234
rating table ---------- 234
Wallowa River near—
Elgin, Oreg.:
description ---------- 235
discharge ---------- 235
discharge, monthly ----- 237
gage heights ---------- 236
rating table ---------- 236
Joseph, Oreg.:
description ---------- 230-231
discharge ---------- 231
discharge, monthly ----- 232

Page.

Wallowa River near—
Joseph, Oreg.—Continued.
gage heights ---------- 231
rating table ---------- 232
Wallowa, Oreg.:
description ---------- 232-233
discharge ---------- 233
discharge, monthly ----- 234
gage heights ---------- 233-234
rating table ---------- 234
Wapatox canal near—
North Yakima, Wash.:
description ---------- 144
discharge ---------- 144
discharge, mean daily --- 145-146
discharge, monthly ----- 146
gage heights ---------- 145
Washington:
miscellaneous measurements in ---------- 275, 284
Weiser, Idaho.
Weiser River near:
description ---------- 219
discharge, monthly ----- 221
gage heights ---------- 220
rating table ---------- 220
Weiser River near—
Weiser, Idaho:
description ---------- 219
discharge, monthly ----- 221
gage heights ---------- 220
rating table ---------- 220
Wenache, Wash.
Pechastin Creek at:
discharge ---------- 275
Wenache River at:
discharge ---------- 275
Wenache Canal Company's canal at—
Cashmere, Wash.:
discharge ---------- 275
Pechastin, Wash.:
discharge ---------- 275
Wenache River at—
Cashmere, Wash.:
description ---------- 71-72
discharge ---------- 72
gage heights ---------- 72
Pechastin, Wash.:
discharge ---------- 275
Wenache, Wash.:
discharge ---------- 275
West Bald Cabin Springs, Idaho.
discharge ---------- 272
West Kittitas canal near—
Thorp, Wash.:
description ---------- 109
discharge ---------- 109
discharge, mean daily --- 111
discharge, monthly ----- 111
gage heights ---------- 110
rating table ---------- 110
Westfall, Oreg.
Bully Creek at:
discharge ---------- 274

Page.

Westfall, Oreg.—Continued.
Malheur River near:
description 203
discharge 204
discharge, monthly 205
gage heights 204
rating table 205
White and Leach ditch in—
Yakima River Valley, Wash.:
data concerning 146, 167–169
White River at—
Buckley, Wash.:
discharge 284
Whitman Spring, Idaho.
discharge 273
Wide Hollow wasteway at—
North Yakima, Wash.:
discharge 275
Wildhorse Creek at—
Pendleton, Oreg.:
discharge 274
Willamette River, Oreg.
discharge 274
Williams Creek, Idaho.
discharge 271
Willow Creek, Idaho.
discharge 272
near Prospect, Idaho:
description 185
discharge 185
gage heights 185–186
Willow Creek, Oregon, near—
Dell, Oreg.:
description 216–217
discharge 217
discharge, monthly 218
gage heights 217
rating table 218
Malheur, Oreg.:
description 215
discharge 216
gage heights 216
Wilson Creek, Wash.
Crab Creek at:
description 73
discharge 73
gage heights 73

Y.

Yakima, Wash.
Sunnyside canal near:
description 127–128
discharge 128
discharge, mean daily 129
discharge, monthly 130
gage heights 128–129
rating table 130
Yakima River near:
description 81–82
discharge 83
discharge, monthly 84
gage heights 83
rating table 84

Page.

Yakima Indian Reservation, Wash.
New reservation canal No. 2, in:
description 123
discharge 123
discharge, mean daily 124
discharge, monthly 125
gage heights 124
rating table 125
Old reservation canal No. 1, in:
description 125
discharge 126
discharge, mean daily 126
discharge, monthly 127
gage heights 126
Yakima River at and near—
Clealum, Wash.:
discharge 275
Easton, Wash.:
description 76–77
discharge 77
discharge, monthly 79
gage heights 77–78
rating table 78
Kiona, Wash.:
description 87–88
discharge 88
discharge, monthly 89
gage heights 88
rating table 89
Martin, Wash.:
description 74
discharge 75
discharge, monthly 76
gage heights 75
rating table 76
North Yakima, Wash.:
description 79
discharge 80
discharge, monthly 81
gage heights 80
rating table 81
Prosser, Wash.:
description 85
discharge 85
discharge, monthly 87
gage heights 86
rating table 86
Thorp, Wash.:
discharge 275
Yakima, Wash.:
description 81–82
discharge 83
discharge, monthly 84
gage heights 83
rating table 84
canals taking water from 165–167
Yakima River Valley, Wash.
canals in 107–169
miscellaneous measurements of 167, 169

Page.

Yakima Valley canal near—
North Yakima, Wash.:
description 149
discharge 149
discharge, mean daily 150–151
discharge, monthly 151
gage heights 149–150
rating table 151
Yelm Prairie, Wash.:
Nesqually River near:
discharge 284
Yoakum, Oreg.
Umatilla River at:
description 260–261

Page.

Yoakum, Oreg.—Continued.
Umatilla River at—Continued.
discharge 261
discharge, monthly 263
gage heights 261–262
rating table 262

Z.

Zindel, Wash.
Grande Ronde River at:
description 229
discharge 230
gage heights 230

O

PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

[Water-Supply Paper No. 135.]

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1890. Twelfth Annual Report, Part II.
1891. Thirteenth Annual Report, Part III.
1892. Fourteenth Annual Report, Part II.
1893. Bulletin No. 131.
1894. Bulletin No. 131: Sixteenth Annual Report, Part II.
1895. Bulletin No. 140.
1896. Water-Supply Paper No. 11; Eighteenth Annual Report, Part IV.
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1898. Water-Supply Papers Nos. 27 and 28; Twentieth Annual Report, Part IV.
1899. Water-Supply Papers Nos. 35, 36, 37, 38, and 39; Twenty-first Annual Report, Part IV.
1900. Water-Supply Papers Nos. 47, 48, 49, 50, 51, and 52; Twenty-second Annual Report, Part IV.
1901. East of Mississippi River, Water-Supply Papers Nos. 65 and 75.
West of Mississippi River, Water-Supply Papers Nos. 66 and 75.
1902. East of Mississippi River, Water-Supply Papers Nos. 82 and 83.
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1903. East of Mississippi River, Water-Supply Papers Nos. 97 and 98.
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SEPTEMBER, 1905.

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300, iii p. illus., II pl. (incl. map) 23cm. (*Its* Water-supply and irrigation paper no. 135)
Subject series: P, Hydrographic progress reports, 40.

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. . . Report of progress of stream measurements for the calendar year 1904. Prepared under the direction of F. H. Newell by D. W. Ross, J. T. Whistler, and T. A. Noble. pt. XII. Columbia River and Puget Sound drainage. Washington, Gov't print. off., 1905.

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O, Underground Waters, 37

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

UNDERGROUND WATERS

OF

SALT RIVER VALLEY, ARIZONA

BY

WILLIS THOMAS LEE

WASHINGTON
GOVERNMENT PRINTING OFFICE
1905

CONTENTS.

	Page.
LETTER OF TRANSMITTAL	9
INTRODUCTION.—Purpose of the investigation	11
CHAPTER I. Well records	12
The Mesa region	12
Murphy-McQueen wells	12
Consolidated Canal Company's wells	17
Plant No. 1	18
Plant No. 2	22
Plant No. 3	24
Plant No. 4	26
Plant No. 5	27
Plant No. 6	28
Plant No. 7	28
Seepage well	29
Olsen wells	30
Hansen wells	31
Tempe Canal Company's wells	33
Valley Seedless Grape Company's wells	33
Tempe waterworks wells	34
Chandler well	37
Flummerfelt well	38
Bartlett-Heard Land and Cattle Company's wells	38
Johnson well	39
Tempe-Mesa Produce Company's well	40
Desert Well	40
Kleinman well	41
Bowen well	42
Harrington well	43
Andrada well	43
Price well	43
Parry well	43
Jenkins seepage ditch	44
Shallow wells	45
Phil Mets and the Alhambra Hotel wells	45
Variation in quality	46
Tabulation of wells	47
The Phoenix region	64
Phoenix Water Company's wells	64
Phoenix Light and Fuel Company's well	66
Perkins well	66
Phoenix Machine and Cold Storage Company's well	67
Bartlett-Heard Land and Cattle Company's wells	67
Well at the Territorial Asylum for the Insane	69
Phoenix Indian School wells	70
G. W. Smith well	72
Kunz well	72
East Lake Park well	73

Page.

CHAPTER I—Continued.
The Phoenix region—Continued.
Wagner well 74
Wetzler well 74
McCallum well 74
Collins well 75
Nelson & McIlwaine wells 76
Perry well 78
Bradshaw well 78
Brown well 78
Harris well 78
Kellner well 79
Ostrich ranch well 79
Moore well 80
Heaton well 80
Hayne well 81
Richardson ditch 81
Cooper well 82
Thomas Murphy well 82
W. J. Murphy well 84
Messinger well 85
Beet-sugar factory well 85
Bartlett well 86
Alkire wells 86
Silva well 87
Miller well 87
Hough well 88
A. H. Smith well 88
Glendale town well 88
Hamilton well 88
J. P. Orme well 89
L. B. Orme well 89
Burrows well 89
Wieder well 90
Fowler well 90
Cole well 90
Tabulation of wells for Phoenix region 90
CHAPTER II.—Geology 95
Pre-Cambrian rocks 95
Carboniferous rocks 97
Tertiary (?) deposits 98
Sedimentary rocks 98
Lavas 100
Quaternary formations 100
Valley fill 101
Structure 101
Material 102
River débris 102
Sheet wash 102
Chemical precipitates 107
Caliche 107
Salts 111
Age 111
Surface movements 115

Page.
CHAPTER III.—Physiography 117
Mountain and plain 117
The Mesa region 118
Water table 119
The river and the underflow 122
Courses of the underflow 123
Ancient river channels 125
Principal courses 128
Sources of the underflow 128
The Phoenix region 131
Distribution of material 131
Geographic changes 133
Water table 133
Extent of bowlder beds 134
CHAPTER IV.—Economics 135
Area of profitable pumping 135
Chemical character of ground water 136
Origin of salts 145
Salts in well water 145
Salts in river water 147
Effects of salts on vegetation 148
In Arizona 148
In Egypt 149
Quantity of underground water 151
The underflow 151
Water entering valley 151
Return water 151
Measuring the underflow 153
Slichter's method 153
Formula 153
Rates of flow 156
Maximum flow 158
Velocity of flow 159
Example 160
Factors in Slichter's method 160
Area of cross section 160
Temperature 161
Porosity 162
Application of Slichter's method 168
Comparative data from other regions 169
Computations of volume 170
The reserve 171
Practical porosity 173
Cost of pumping 177
In Salt River Valley 177
In other regions 179
Arizona, Wisconsin, and California 179
New Mexico 180
California 181
Egypt 182
Value of water 183
Location of pumping plants 184
RÉSUMÉ 186
INDEX 189

ILLUSTRATIONS.

		Page.
PLATE I.	Map of central Arizona, showing area described	11
II.	Murphy-McQueen pumping plant	12
III.	Pumping water by electricity at Consolidated Canal Company's plant No. 1	18
IV.	*A*, Edge of the mesa near the Consolidated Canal Company's power plant; *B*, A. J. Hansen's pumping plant	28
V.	*A*, Tempe Butte, showing reservoir near the top; *B*, Collins well, near Phoenix, Ariz	34
VI.	Irrigation by means of buckets at J. D. Cooper's pumping plant near Tempe, Ariz	82
VII.	Geologic map of part of Salt River Valley, Arizona	In pocket.
VIII.	*A*, Tilted pre-Cambrian quartzites and argillites in the Phoenix Mountains; *B*, Phoenix Peak, north of Phoenix, Ariz	96
IX.	*A*, Salt River dam site, looking upstream into Tonto basin; *B*, Side canyon in Tonto basin	96
X.	Tilted formations at upper end of Tonto basin	98
XI.	*A*, Camelback Mountain near Phoenix, Ariz.; *B*, Buttes north of Tempe, Ariz	98
XII.	Tempe Butte	100
XIII.	*A*, Bell Butte, near Tempe, Ariz.; *B*, North end of Superstition Mountains	100
XIV.	*A*, Clay bank in Tonto basin; *B*, Tilted breccia in Tonto basin	112
XV.	Map of base of Phoenix Mountains, showing small outlying points partly submerged in débris	118
XVI.	*A*, Camelback Mountain from near power house on the Arizona canal, rising abruptly from the detrital plain; *B*, Seepage land near Tempe, Ariz	118
XVII.	View eastward from Tempe Butte	118
XVIII.	Map and sections of Mesa Township, Salt River Valley, Arizona, showing position of water table	120
XIX.	Sections indicating relation of water table to river and land surfaces	122
XX.	Map of part of Salt River Valley, showing position of water table	In pocket.
XXI.	*A*, Section through Tempe Butte to Salt River Mountains; *B*, Section across Salt River Valley near Phoenix; *C*, Section from Salt River Mountains to Sacaton Mountains	126
XXII.	*A*, An orchard near Phoenix killed by lack of water; *B*, Desert near Tempe, Ariz., showing typical desert vegetation	148
XXIII.	*A*, Seepage land southeast of Tempe, Ariz.; *B*, View southward from Tempe Butte	150

Page.

FIG. 1. Bored well of S. J. Murphy on Murphy-McQueen ranch, Mesa, Ariz.. 12
2. Diagram showing water level, after pumping, in wells at Murphy-McQueen plant, near Mesa, Ariz..... 14
3. Ideal cross section in Salt River Valley illustrating migrations of river as valley floor was built up..... 16
4. Diagram showing depression of water table during pumping test No. 1 of Consolidated Canal Company's pumping plant, Mesa, Ariz..... 19
5. Diagram showing depression of water table during pumping test No. 2 of Consolidated Canal Company's pumping plant..... 19
6. Diagram showing depression of water table during pumping test No. 3 of Consolidated Canal Company's pumping plant..... 20
7. Diagram showing depression of water table during pumping test No. 4 of Consolidated Canal Company's plant..... 20
8. Diagram showing depression of water table during pumping test No. 5 of Consolidated Canal Company's pumping plant..... 20
9. Diagram showing water levels before and after pumping from seepage well of Consolidated Canal Company..... 29
10. Depression of water table during pumping test of the Bartlett-Heard well..... 68
11. Section through Salt River gorge at Tonto dam site..... 97
12. Cross section of Verde Valley near Mount McDowell, Arizona..... 101
13. Daily discharge of Queen Creek, Arizona..... 106
14. Diagrammatic illustration of valley filling and of central and western Arizona..... 113
15. Geologic map of Tempe Butte, Arizona..... 116
16. Section through Tempe Butte and Tempe well..... 116
17. Sketch profile from the Agua Fria, through Tonto basin and the Sierra Ancha..... 117
18. Sketch section illustrating the restricted area of water-bearing gravels due to underground structure..... 118
19. Index map of Salt River Valley locating the sections shown in Pl. XIX. 122
20. Index map of Salt River Valley locating the sections shown in Pl. XXI. 124
21. Map of Salt River showing area beneath which water is 50 feet or less below surface..... 135
22. Diagram illustrating various pressure gradients and maximum flow.. 158
23. Diagram showing lines of flow into a drainage ditch..... 159
24. Map of Salt River Valley showing location of pumping plants described..... 176
25. Diagrammatic illustrations of underground conditions affecting yield of wells..... 185

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
HYDROGRAPHIC BRANCH,
Washington, D. C., June 1, 1904.

SIR: I forward herewith a report on the underground waters of Salt River Valley, Arizona, by Willis T. Lee, and recommend that it be published as a water-supply and irrigation paper.

Mr. Lee, under the direction of Mr. N. H. Darton, geologist in charge of the western section of hydrology, has made a detailed investigation of the underground waters and geology of Salt River Valley, in the Phoenix region and eastward, and I believe the results will be of value and interest to a large number of persons. The region is one in which the problem of water supply is of great importance, for its prosperity is entirely dependent upon the utilization of the surface and underground waters.

Very respectfully,

F. H. NEWELL,
Chief Engineer.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

Scale
0
5
10
15 miles
B
Tonto
Clantons Ranch
Cline
SIERRA ANCHA
Greenback Cr.
Cherry
Cr.
Cedar
SAN CARLOS INDIAN RESERVATION
Dutch Woman Butte
SALT RIVER RESERVOIR SITE
U.S. DAM SITE (AUTHORIZED)
Roosevelt
Livingstone
Cornin Ranch
Bronco Cr.
Pine Cr.
Campaign Cr.
Narins Ranch
Frisbees Ranch
Tortilla Ranch
Fraseres Ranch
Pinal Cr.
Black Warrior
Globe
Gila Valley, Globe & Northern Ry.
11
12
13
14
15
Kings Crown Peak
Silver King
Superior
PROPOSED FOREST RESERVE

UNDERGROUND WATERS OF SALT RIVER VALLEY, ARIZONA.

By Willis T. Lee.

INTRODUCTION.

PURPOSE OF THE INVESTIGATION.

The purpose of this paper is to bring together the facts, so far as known, regarding the underground waters of Salt River Valley, with a view to ascertaining their available quantity, the areas where they occur sufficiently near the surface for economic pumping, and their adaptability for irrigation.

The area of special investigation lies within a line drawn from the junction of Verde and Salt rivers westward a few miles beyond the Agua Fria and southward to Gila River; thence along the northern border of the Pima Indian Reservation to the Superstition Mountains north of Florence, and along the foot of these mountains to the mouth of Verde River—an area, irrespective of the mountains, of about 1,000 square miles. A number of side trips were made beyond this area into the neighboring mountainous districts, but the principal part of the work was done in the lowlands included within the above boundaries. This area is conveniently divided into two districts by a line of buttes that extends across the valley in the vicinity of Tempe, connecting the Phoenix Mountains with the Salt River Mountains. The physical conditions existent east of this line of buttes differ notably from those to the west of it. The division of the valley into two districts is therefore to more purpose than mere convenience of description. The first district, which extends from the mouth of the Verde to Tempe, is known as the Mesa region, and the second, which extends from Tempe to the Agua Fria, is known as the Phoenix region. (See Pl. I.)

CHAPTER I.

WELL RECORDS.

THE MESA REGION.

MURPHY-McQUEEN WELLS (SEC. 34, T. 1 N., R. 5 E.).

The series of deep wells first completed and used for irrigation in Salt River Valley is that on the Murphy-McQueen ranch, near the town of Mesa. This series of wells has been described by W. H. Code in two publications,[a] and his descriptions are here transcribed. In the first he writes:

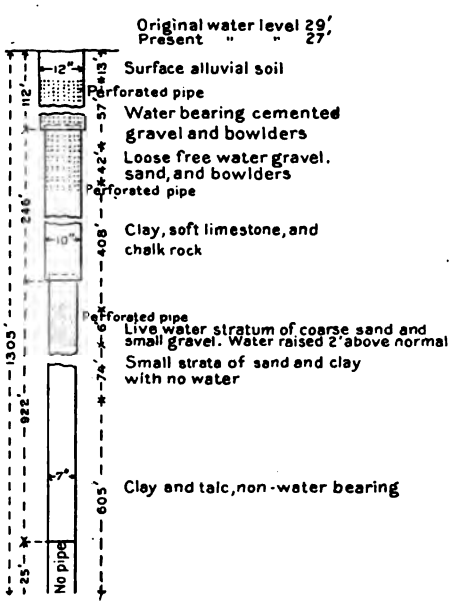


FIG. 1.—Bored well of S. J. Murphy, on Murphy-McQueen ranch, Mesa.

The Murphy well (fig. 1) was started as a 12-inch double-steel-cased one, but on account of the great difficulties encountered in the way of bowlders and cement strata, together with a peculiar formation of clay known as the swelling variety, it has been necessary to reduce the size of the well three times in the depth of 1,305 feet, ending with a casing 7 inches in diameter.

In the later and more complete report Mr. Code writes as follows:

Four 12-inch bored wells were sunk on a line, with 12½-feet centers. The first one was put down 1,305 feet in the hope that an artesian flow might be obtained. As the drill was still in a nonwater-bearing stratum of clay and talc when this depth was reached it was decided, after having penetrated this stratum 605 feet, to abandon the search for artesian flow and depend upon pumps for raising the water. The remaining three wells, therefore, were drilled to a depth of approximately 212 feet, the formations intercepted being as follows:

[a] Code, W. H., Report of irrigation investigations for 1900, No. 2: U. S. Dept. Agric., Bull. 104, 1901, p. 93; Report of irrigation investigations for 1901, No. 1: U. S. Dept. Agric., Bull. 119, 1902, pp. 65–68.

MURPHY-McQUEEN PUMPING PLANT.

Record of wells bored on Murphy-McQueen ranch.

	Feet.
Surface alluvial soil	13
Cemented gravel and bowlders	157
Loose free water gravel, sand, and bowlders	42
Total	212

Below this depth lay another stratum of clay, soft limestone, and chalk rock, 408 feet in thickness.

The pipes were all perforated thoroughly, and a central shaft was sunk to a depth of about 23 feet, which was very close to the normal water level, and from the bottom of this shaft tunnels were run in either direction in order that small sections of the steel well casings might be removed at this level and the wells all connected to one horizontal suction pipe. The four wells were connected by means of a longitudinal suction pipe, from which were suspended the vertical suction pipes leading down in each well to a depth of 25 feet or more below normal water level. The longitudinal pipe was attached to a 12-inch horizontal centrifugal pump having a capacity of 4,000 gallons per minute and located at the bottom of the shaft. The pump was driven by a steam plant, which, in brief, consisted of the following: One boiler, 5 by 16 feet, estimated capacity 80 horsepower; 1 automatic 12 by 16 inch engine, running condensing; 1 brick cement-lined condensing pit, 10 by 22 feet and with a depth of 5 feet, containing 40 2-inch pipes 20 feet in length.

The steam is condensed in the pipes by the water discharged from the centrifugal pump, which passes through the pit previous to its discharge into the irrigating ditches leading to the alfalfa fields. The machinery is all inclosed by a neat brick house, and the entire plant has a substantial appearance. [Pl. II.]

The writer was employed to superintend a test run of the plant after its completion, and through the courtesy of the owners is privileged to embody the following data from the report made to them.

The test run of the plant was begun at 7 a. m., July 4, 1901, and was completed at 7 p. m., July 11, 1901. The intention was to operate continuously for six days, but, owing to a twelve hours' enforced stop for repairs to the engine on July 8, the time was extended to six and one-half days. The average height to which the water was raised during the test was about 44 feet, the discharge pipe being several feet above the ground level. The machinery was run to its maximum economical capacity, and the results obtained were as follows:

Data obtained by test run of pump on Murphy-McQueen ranch.

Number of hours consumed in test	156
Number of hours consumed in stoppages (breaks, oilings, etc.)	26.4
Total number of hours operated	129.6
Average number of inches pumped (Arizona measure)	270
Average number of inches pumped (California measure)	338
Total number of acre-feet pumped	72.4
Total cords of fuel used	34.75
Daily expense of twenty-four hours' run, aside from fuel:	
Two engineers, at $2.25 per diem	$4.50
Two firemen, at $1.50 per diem	3.00
Oil and waste	.75
Estimated cost of repairs and maintenance	1.00
Total	9.25

Total expense of operation during test:	
6½ days, at $9.25 per diem	$60.12
34¾ cords of wood, at $3 per cord	104.25
Total	164.37
Cost per acre-foot of water pumped:	
Total cost of pumping	$164.37
Acre-feet of water pumped	72.40
Cost per acre-foot	$2.27
Expense for each hour actually running:	
Total expense	$164.37
Number of hours actually run	129.60
Cost per hour	$1.26
Lift, in feet	44
Average cost per foot of raising an acre-foot of water	$0.05–

The normal level of water previous to the test was 22½ feet below the average surface of the ground. The water level in each of the wells at the end of the test is shown in fig. 2. The sketch shows that the water in the deep well was not drawn

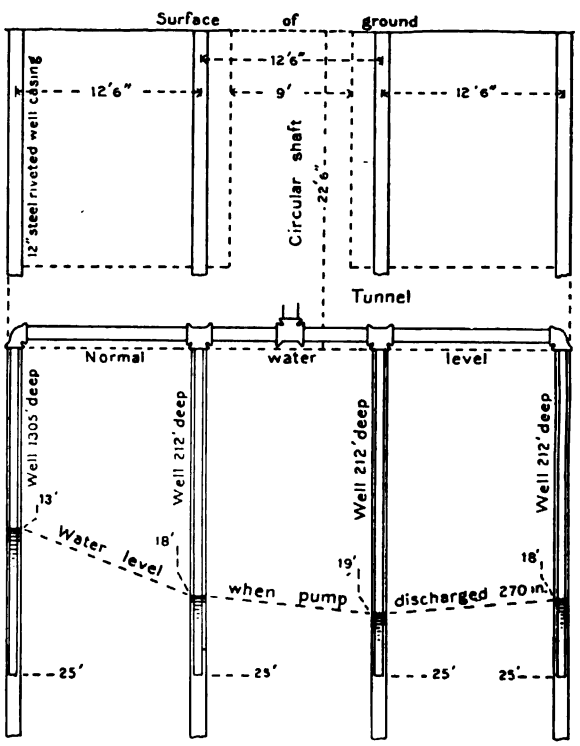


FIG. 2.—Diagram showing water level, after pumping, in wells at Murphy-McQueen plant, near Mesa.

down to within 5 feet or more of the level in the other three wells, which seemed to indicate that the well driller was right when he affirmed that it would furnish the greatest supply of water. He based his opinion upon the fact that at a depth of 620 feet, after having penetrated an impervious stratum of clay 408 feet in thickness,

a 6-foot gravel stratum was encountered which caused the water level in the pipes to rise 2 feet above the normal level.[a]

Two samples of pumped water were sent to Prof. R. H. Forbes, of the University of Arizona, at Tucson, to be analyzed for the purpose of ascertaining its value for irrigation purposes. The first was obtained shortly after the pump was started, and the second near the end of the test run; and it will be noted that the analysis of the latter showed considerable decrease of salts, which would warrant the assumption that continued pumping would effect further improvement. In the opinion of Professor Forbes it would not be wise to depend on well water alone for irrigation purposes, but where it can be used in connection with large quantities of silty river water the danger of depositing an excess of salts on the lands is minimized. The following table gives the results of the analyses made by Professor Forbes:

Analyses of water from Murphy-McQueen wells.

[Laboratory No. 2615, May 17, 1901.]

Quantitative (parts in 100,000):	
Total solids soluble at 110° C	133.20
Chlorine as NaCl (common salt)	82.00
Hardness as $CaSO_4$ (sulphate of lime)	11.15
Nitrogen as nitrates	.426
Nitrogen as nitrites	.0067
Qualitative:	
Sulphates	Very strong.
Magnesia	Very strong.
Lime	Very strong.
Bicarbonates	Pronounced.
Silt	Small amount.

[Laboratory No. 2670, June 27, 1901.]

Quantitative (parts in 100,000):	
Total solids soluble at 110° C	123.20
Chlorine as NaCl (common salt)	74.60
Hardness as $CaSO_4$ (sulphate of lime)	9.79
Nitrogen as nitrates	.263
Nitrogen as nitrites	Trace.
Qualitative:	
Sulphates	Very strong.
Magnesia	Very strong.
Lime	Very strong.
Bicarbonates	Pronounced.
Silt	Slight traces.

Since the first Murphy-McQueen well is the deepest in the valley and penetrates formations that no other well penetrates, it may be in place here to anticipate certain conditions which will be described later and to comment on questions which are of vital importance to those who intend to establish pumping plants in other parts of the valley. First, the principal water-bearing formation is comparatively near the surface, but after penetrating a thickness of 408 feet of impervious material another water-bearing stratum is encountered. This stratum,

[a] The writer measured the depth to water in these wells on January 19, 1904, and found the distance to be 34 feet. In the four years, therefore, since Code's measurements were made the water table at this point has lowered 11.5 feet.

although only 6 feet thick, is not local in occurrence, as is shown by the quantity of water it supplies. As already stated, the water from this stratum rose 2 feet higher than that from the horizon above. The log of the well is given below:

Log of bored well of S. J. Murphy, on Murphy-McQueen ranch, Mesa, Ariz.

	Feet.
Surface soil	13
Cemented gravel and bowlders, water bearing	159
Loose gravel, sand, and bowlders, water bearing	42
Clay, "soft limestone, and chalk rock"	408
Gravel and coarse sand, water bearing	6
Alternating layers of sand and clay	72
Clay and "talc"	605
Total	1,305

Only one other well in the Mesa region has penetrated to the depth of the lower flow. One of the first series of wells on the Chandler ranch is 705 feet deep, but did not encounter this sand. This, however, does not necessarily indicate that the lower stratum may not be

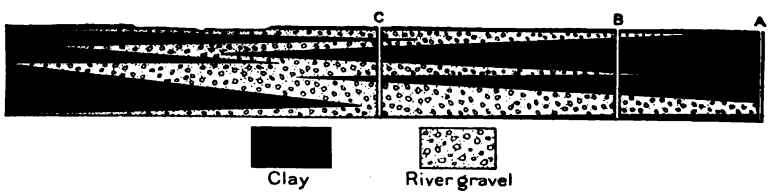


FIG. 3.—Ideal cross section in Salt River Valley, illustrating migrations of river as valley floor was built up.

found in other parts of the valley. Variation and abrupt change in the character of the valley fill, both vertically and horizontally, render it as probable that this stratum increases in thickness and perhaps passes into bowlder beds riverward as that it thins and disappears. Since the river is the main source of the valley fill, and since it is the only source of the extensive bowlder beds in the center of the valley, we naturally expect more or less coarse material from bottom to top of the valley fill. As the river swung back and forth across the valley in the process of depositing the valley fill, we should expect to find the greatest amount of coarse material in the center of the valley, although occasional layers should be found near the outer edges where the river left it during an excursion to the side. However, as explained in another place, the hill wash is always working downward to meet the river wash. The natural result is that at any given horizon bowlders should be found where the river flowed at the time the horizon was the land surface. Back from the river the material should be finer, perhaps sand, and still farther back it should run into clay, silt, cement, or wash, as the case may be.

This change in deposits is illustrated in fig. 3, in which A represents a well some distance from the center of the valley, and B another, more nearly medial. In A bowlders and water are encountered only at a considerable depth (the case with one of the Chandler wells), while at B they are found near the top and again midway. If the well does not go through the second clay we have the case of the Murphy-McQueen well. In this case the same horizon in A yields no water—as was just cited in the 705-foot Chandler well. Wells put down in the center of the valley would probably encounter a greater aggregate thickness of water-bearing gravel, while a well at the extreme left would be entirely outside of the water-bearing sands and gravels and yet be in purely fluviatile material.

An attempt was made to take the temperature of the 1,305-foot well. At a depth of 349 feet the thermometer lodged apparently in sand. The temperature at this depth was found to be 78.1° F. At a depth of 150 feet the temperature is 77.6° F., an increase downward of only 0.5° for 199 feet.

CONSOLIDATED CANAL COMPANY'S WELLS.

The Consolidated Canal Company owns a large central power plant situated at the edge of the mesa north of the town of Mesa. The plant is so constructed that water power may be used when water can be secured in sufficient quantities. Water for the Tempe canal is taken from the river at the upper end of the valley and conducted through the consolidated canal to the surface of the mesa, where it descends through the power plant to the lower level of the Tempe canal. During times of low water the power is created by steam, using crude oil as fuel. According to P. E. Fuller, the engineer in charge, the plant is supplied with two 250-horsepower water-tube boilers, one 400-horsepower compound condensing engine, one 300-kilowatt electric generator, and a complete fuel-oil system, together with necessary auxiliary equipment. The plant supplies electric power to the towns of Mesa and Tempe, but is principally used in pumping water for irrigation. The electric power is transmitted to the pump stations at 11,000 volts, where it is transformed to 220 volts for the 50-horsepower motors. Power is supplied at present to four pumping plants, each yielding about 200 inches of water continuously. The power plant is designed for a maximum of six pumping plants, yielding a total of 1,200 inches of water. About 3,300 acres of land are now supplied with water from the four pumps and this acreage is being rapidly increased. Each pumping plant cost $8,000 complete, while the central power plant cost $50,000.

Mr. Fuller has conducted certain experiments on the cost of pumping water, some of which are quoted in detail later. His general conclusion is as follows:

The water is lifted a total distance of 50 feet and the water-horsepower is 28.33. The actual power consumed at the motor in pumping this water is 42.88, representing a combined efficiency of 66.06 per cent. A number of losses occur from the engine shaft to the motor, and it therefore requires 57.17 horsepower at the engine shaft to pump 200 inches of water, and, as this represents 28.33 water-horsepower, there is a total efficiency for the plant of 49.55 per cent.

Oil costs $1.65 a barrel of 42 gallons. The fuel item I found to be 1 cent per horsepower per hour at the engine shaft, or 57.17 cents per hour for 200 inches of water, or 0.285 cents per inch per hour. Inasmuch as the lifts in the various plants here discussed are different, I have resolved into cost per inch, per foot, and per hour. The above plant costs on this basis 0.0057 of a cent per inch per foot lift per hour.

PLANT NO. 1.

The first pumping plant was established about 6 miles south of Mesa (sec. 22, T. 1 S., R. 5 E.). There are three double-steel-cased 12-inch drilled wells 15 feet apart. They are 705 feet, 236 feet, and 146 feet deep, respectively. At a depth of 80 feet a gravel and bowlder bed 156 feet thick was encountered. The water from this bed is admitted through perforations in the casing and rises to within 36 feet of the surface. Below the bowlder bed occurs a clay containing small bands of sand and gravel and continuing downward at least to a depth of 705 feet, the depth of the well. Following is a log of the well:

Log of the Consolidated Canal Company's well at plant No. 1.

	Feet.
Soil and clay	42
Sand	3
Clay and cement	35
Gravel and bowlders, water bearing	156

Over the central well a shaft 9 feet in diameter is sunk to a depth of 31 feet. From the bottom of this tunnels are run laterally to communicate with the wells on either side. A horizontal suction pipe, from which a vertical suction pipe extends into each well, as described for the Murphy-McQueen plant, connects the wells. An 8-inch horizontal centrifugal pump is placed at the bottom of the shaft in order to be within suction distance of the water, and an electric motor is attached by direct connection. The water is thus drawn from the wells by suction and forced to the surface above through a large delivery pipe. (See Pl. III.)

Several instructive pumping tests were made at this plant in the spring of 1902 for the purpose of ascertaining the capacity of the wells both individually and collectively and the effect upon the general water level.

Pumping tests of the Consolidated Canal Company's plant No. 1.

[March 10, 1902.]

Original depths of wells:	Ft.	in.
North well	705	0
Central well	146	0
South well	236	0

PUMPING WATER BY ELECTRICITY AT CONSOLIDATED CANAL COMPANY'S PLANT NO. 1.

Depth of water below the surface previous to starting the pump:

	Ft.	in.
North well	34	8½
Central well	34	8
South well	34	11

Test No. 1.—Central well alone (others being shut off): After two hours' steady pumping the water stood (below surface):

	Ft.	in.
North well	36	7½
Central well	55	4
South well	36	3

Quantity pumped: 50 inches (563 gallons per minute).[a]

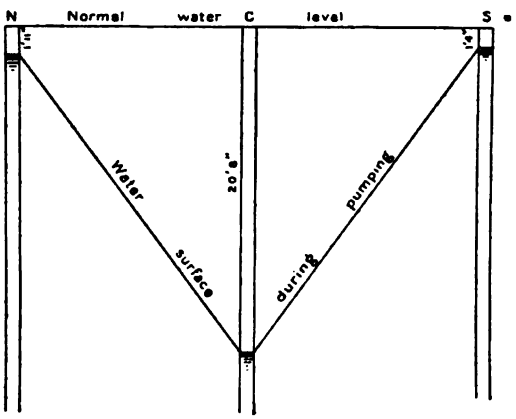


FIG. 4.—Depression of water table during test No. 1.

Test No. 2.—North well (others being shut off): After seven hours' steady pumping the water stood (below surface):

	Ft.	in.
North well	46	6
Central well	38	0
South well	36	8

Quantity pumped: 83 inches (934 gallons per minute).

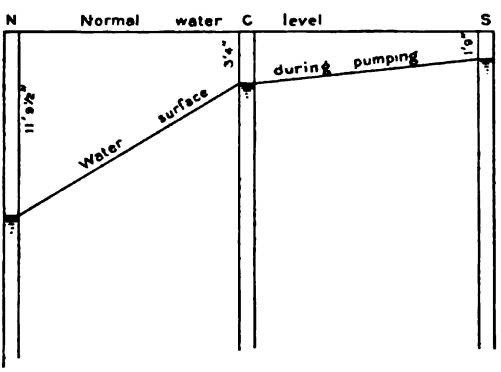


FIG. 5.—Depression of water table during test No. 2.

[a] Measurements of water in this paper are given in "Arizona inches." The measurements are reduced to absolute quantities by reckoning 40 inches as equivalent to the discharge of 1 cubic foot of water per second.

Test No. 3.—South well alone (others being shut off): After two hours' steady pumping the water stood (below surface):

	Ft.	in.
North well	36	5
Central well	36	5
South well	48	5

Quantity pumped: 75 inches (844 gallons per minute).

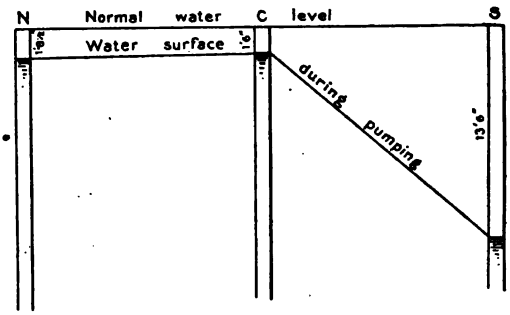


FIG. 6.—Depression of water table during test No. 3.

Test No. 4.—North and south wells coupled (central well shut off): After pumping one hour the water stood (below surface):

	Ft.	in.
North well	42	7
Central well	38	9
South well	43	7

Quantity pumped, 128 inches (1,440 gallons per minute).

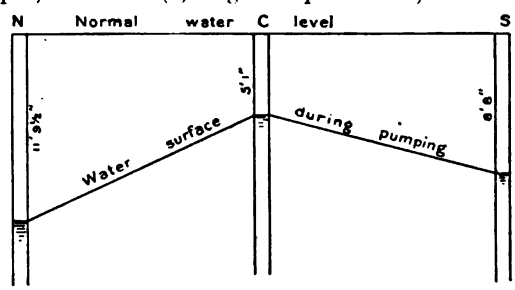


FIG. 7.—Depression of water table during test No. 4.

Test No. 5.—All wells combined: After pumping several hours the water stood (below surface):

	Ft.	in.
North well	41	4
Central well	41	2
South well	40	8

Quantity pumped, 128 inches (1,440 gallons per minute).

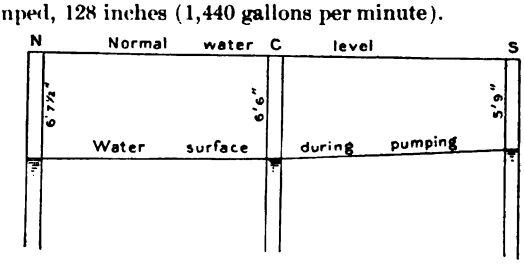


FIG. 8.—Depression of water table during test No. 5.

Analyses of water from wells at Consolidated Canal Company's plant No. 1.[a]

	1. Analysis of water taken from 705-foot well before any extensive pumping had been done.	2. Analysis of water taken from 236-foot well soon after establishment of plant but after thorough pumping.	3. Analysis of water from wells at plant No. 1 after the pump had been in occasional operation for about fifteen months.	4. Analysis of water from wells at Consolidated Canal Co.'s plant No. 1 after long-continued pumping.
Quantitative (parts in 100,000):				
Total soluble solids at 110° C.	299.60	163.80	127.40	179.00
Chlorine in terms of NaCl (common salt)	154.80	104.40	75.60	116.80
Hardness in terms of $CaSO_4$ (sulphate of lime)	20.90	44.50	23.10	53.30
Alkalinity in terms of Na_2CO_3 (black alkali)	.00	.00	.00	.00
Nitrogen in the form of nitrates	.29	.12	.07	Trace.
Nitrogen in the form of nitrites	.0105	Very faint.	Trace.	.00
Qualitative:				
Sulphates	Very strong.	Very strong.	Strong.	Very strong.
Magnesia	Strong.	Very strong.	Distinct.	Strong.
Lime	Strong.	Very strong.	Pronounced.	Strong.
Bicarbonates	Strong.	Strong.	Strong.	Slight.

[a] These analyses, as well as the greater number of those to follow, were made by Prof. R. H. Forbes and W. W. Skinner, at the Government experimental laboratory at Tucson, Ariz.

The sample of water represented by analysis No. 2 was taken after the well had been thoroughly cleared by pumping. It may therefore be taken as representative of the true quality of the water pumped at the time the sample was taken. Samples from the other two wells were taken at the same time. That from the 705-foot well yielded 157.40 parts of total soluble solids in 100,000 parts of water, and that from the 146-foot well showed 172.20 parts in 100,000. The analysis of the water from the 236-foot well given above may be taken, therefore, as an average representative of the three wells.

An inspection of these figures brings clearly to mind the fact that the water in a well not in active operation is not a fair representative of the general supply, there being in this case at least a difference of 135.8 parts of soluble salts in 100,000 parts of water. There are many instances in the valley where water for analysis has been taken under similar circumstances and are therefore of questionable value. The inspection also reveals a difference in the proportion of the various salts, which may be due to one or more of several causes, such as the commingling of the waters of different composition, the contact of these waters with new formations, chemical reactions within the steel casing, exposure to the atmosphere, or the relief of pressure. The last two would apply especially to alterations in the bicarbonates, which are abundant in these waters. The relief of pressure and the exposure to the atmosphere would have a tendency to allow the escape of the carbon dioxide necessary to keep the normal carbonates in solution and thus allow the bicarbonates to change to their insoluble form and be

deposited. There should therefore be a smaller showing of lime in standing water than in that drawn from the deeper unexposed sources. In the above samples the proportion is 20.90 to 44.50, the samples being taken from the same well before and after thorough clearing of the well by pumping.

The lime is stated in terms of calcium sulphate. This does not mean that the lime is of necessity combined as a sulphate. Much of the lime reckoned as calcium sulphate probably occurs as calcium bicarbonate. The loss of carbon dioxide (CO_2) from this compound, which occurs when the pressure is relieved, as in the case of transferring the water from the well to the surface, changes it to the comparatively insoluble calcium carbonate ($CaCO_3$), which is deposited as a solid. This phenomenon of deposition of lime when water stands exposed is well illustrated in the annoying deposition of lime in kettles and drinking cups in which water containing carbonates is used.

The third analysis indicates a marked decrease in the amount of soluble salts. There is a popular belief throughout the valley that wells improve by use. In many cases where the judgment is based upon taste it is probable that the quality of the water has changed less than the taste of the persons using it. In the case of the Chandler wells, however, the analyses seemed to indicate that there might be an actual and notable improvement in the water as the wells are used. On the other hand, a change in the opposite direction is indicated by the analyses of the Phoenix city supply, which are given in the description of the Phoenix wells. The improvement of the water by the continued use of the wells is so desirable that too much importance is likely to be attached to any indication of such improvement. This is well illustrated in analysis No. 4, above. After the sample for No. 3 was taken the well was in continuous operation for about nine months, when the sample was taken for analysis No. 4. If continuous pumping will improve the quality of the water the last analysis should show improvement. On the contrary, it indicates a notable increase in the salt contents.

An attempt was made January 19, 1904, to take the temperature of the 705-foot well. It was found, however, that the well had filled with sand to the 375-foot level. The temperature at this depth is 84.6° F., while the temperature at the depth of 150 feet was found to be 81.1° F., making an increase in temperature downward of 1° F. for 64.3 feet.

PLANT NO. 2.

A second pumping plant, similar in construction to No. 1, has been established 1,000 feet east of the former. Two 15-inch double-steel-cased wells have been put down to a depth of a little over 246 feet, and a central shaft 31 feet deep, with a tunnel connecting it with the wells on either side, has been constructed, containing a 10-inch centrifugal pump and electric motor, as described for the first plant.

This plant was completed in June, 1903, and a careful pumping test was made, the results of which are kindly furnished by Dr. A. J. Chandler for this report. The tests were conducted under the direction of Mr. P. E. Fuller.

Log of well at Consolidated Canal Company's plant No. 2.

	Feet.
Soil, clay, and cement	22
Cement	14
Sand, water bearing	10
Cement	6
White clay	30
Sand, gravel, and bowlders	164
Yellow clay	(?)

Pumping test of wells at Consolidated Canal Company's plant No. 2.

[Data furnished by Dr. A. J. Chandler.]

AVERAGE OF READINGS OF BYRON JACKSON 10-INCH HORIZONTAL CENTRIFUGAL PUMP.

[Readings for 30 minutes averaged.]

Speed, r. p. m	852
Vacuum, in feet	15.30
Pressure, in pounds	13.75
Head, in feet, between gages	3.66
Head, in feet, due to vacuum	15.30
Head, in feet, due to pressure	31.68
Total head, in feet	50.65
Depth of water in 36-inch weir	7.75
Miner's inches flowing	197.5
Net water horsepower	28.33

Miner's inch taken at 1½ cubic feet per minute.

AVERAGE OF READINGS OF WESTINGHOUSE TYPE "O" TWO-PHASE MOTORS.

Speed of motor, r. p. m	852
Total amperes in both phases	188
Difference of potential	205
Apparent energy, kilowatts	38.54
Watt meter speed	40
True energy, in kilowatts	32.80
Power factor	83.03
Actual horsepower consumed	42.88
Combined efficiency	66.06
Efficiency for motor	82.50
Efficiency for pump	80

Efficiencies for units are correct. Others based upon pump guaranty.

From the figures thus obtained the cost of raising water is computed:

Computation of cost for pumping plant No. 2 of the Consolidated Canal Company.

Cost of wells and machinery	$8,000.00
Interest on investment at 7 per cent per annum for 2.44 hours	$0.16
Depreciation at 10 per cent per annum for 2.44 hours	$0.23
Time in hours to pump 1 acre-foot of water	2.44

80.03 kilowatts, at 3 cents	$2.40
Oil and incidentals (estimated)	$0.05
Total cost per acre-foot	$2.84
Lift, in feet	50.64
Average cost per foot in lifting 1 acre-foot of water	$0.056

In computing the cost, the cost of the power used could not be ascertained owing to the lack of definite experiments in the development of that power. This item is therefore reckoned at the rate at which it would be furnished by the Electric Light and Fuel Company of Phoenix.

PLANT NO. 3 (SEC. 34, T. 1 S., R. 5 E.).

A third pumping station has been established about 2 miles south of the first. Two double-steel-cased 15-inch wells have been drilled 262 feet deep, and provided with a 10-inch centrifugal pump and an electric motor, as in the wells previously described. The water-bearing gravels lie 42 feet deeper here than in the first set of wells, and the gravel beds are correspondingly thinner. But the water rises to practically the same elevation as in the other wells, 37 feet below the ground surface. Following is a log of the well:

Log of well at Consolidated Canal Company's plant No. 3.

	Feet.
Surface soil	4
Sand	3
Hardpan	5
Sand	4
Clay	8
Sand	12
Clay	8
Cement	6
Sand, water bearing	10
Clay	20
Cement	4
White clay	16
Yellow clay	10
Green clay	12
Gravel and bowlders, water bearing	136
Clay and sand	4

The plant was put in operation in June, 1903, and a pumping test made under the direction of Mr. Fuller.

Pumping test of wells at Consolidated Canal Company's plant No. 3.

[Data furnished by Dr. A. J. Chandler.]

AVERAGE OF READINGS OF BYRON JACKSON 10-INCH HORIZONTAL CENTRIFUGAL PUMP.

[Readings for 30 minutes averaged.]

Speed, r. p. m.	860
Vacuum, in feet	14.30
Pressure, in pounds	12.50

Head, in feet, between gages	3.85
Head, in feet, due to vacuum	14.34
Head, in feet, due to pressure	29.37
Total head, in feet	47.56
Depth in water in 36-inch weir	7.87
Miner's inches flowing	202
Net water horsepower	27.22

Miner's inch taken at 1½ cubic feet per minute.

AVERAGE OF READINGS OF WESTINGHOUSE TYPE "O" TWO-PHASE MOTORS.

Speed of motor, r. p. m	860
Total amperes in both phases	186
Difference of potential	205
Apparent energy, kilowatts	38.13
Watt meter speed	40
True energy, in kilowatts	32
Power factor	83.09
Actual horsepower consumed	42.88
Combined efficiency	63.48
Efficiency for motor	80.80
Efficiency for pump	78.50

Efficiencies for units are correct. Others are based upon pump guaranty.

From the figures obtained in this test the computation of cost is as follows:

Computation of cost of well No. 3 of the Consolidated Canal Company.

Cost of wells and machinery	$8,000.00
Interest on investment at 7 per cent per annum for 2.4 hours	$0.15
Depreciation at 10 per cent per annum for 2.4 hours	$0.19
Time in hours to pump 1 acre-foot	2.4
Kilowatts used to pump 1 acre-foot	76.8
76.8 kilowatts, at 3 cents	$2.30
Oil and incidentals (estimated)	$0.05
Total cost per acre-foot	$2.69
Lift, in feet	47.56
Average cost per foot in lifting 1 acre-foot of water	$0.054

Analyses of water from wells at Consolidated Canal Company's plant No. 3.

	Sample taken before any pumping had been done.	Sample taken after thorough pumping.	Sample taken after the pump had been in continuous operation for about eight months.
Quantitative (parts in 100,000):			
Total solids soluble at 110° C.	162.40	84.80	82.60
Chlorine in terms of NaCl (common salt)	80.40	44.60	41.20
Hardness in terms of $CaSO_4$ (sulphate of lime)	52.20	18.50	1.10
Alkalinity in terms of Na_2CO_3 (black alkali)	.00	.00	.00
Nitrogen in the form of nitrates	.274	.266	.10
Nitrogen in the form of nitrites	.0061	Trace.	.0
Qualitative:			
Sulphates	Very strong.	Strong.	Strong.
Magnesia	Strong.	Distinct.	Distinct.
Lime	Very strong.	Strong.	Distinct.
Bicarbonates	Strong.	Very strong.	Strong.

PLANT NO. 4 (SEC. 34, T. 1 S., R. 5 E.).

A fourth pumping station has been established about a quarter of a mile east of No. 3. There are two double-steel-cased wells about 200 feet deep, equipped with electric motor and pump as described for the other plants belonging to this company. The plant was put in operation about January 1, 1904. No pumping tests have yet been made, but the plant yields apparently the same volume of water as the wells just described.

Analysis of water from wells at Consolidated Canal Company's plant No. 4.

[Sample taken January 28, 1904.]

Quantitative (parts in 100,000):	
Total solids soluble at 110° C.	69.00
Chlorine in terms of NaCl (common salt)	40.00
Hardness in terms of $CaSO_4$ (sulphate of lime)	14.70
Alkalinity in terms of Na_2CO_3 (black alkali)	.00
Nitrogen in the form of nitrates	.20
Qualitative:	
Sulphates	Strong.
Magnesia	Distinct.
Lime	Distinct.
Bicarbonates	Strong.

PLANT NO. 5 (SEC. 15, T. 2 S., R. 5 E.).

A fifth pumping plant was started about 11 miles south of Mesa, where a 15-inch double-steel-cased well was sunk 365 feet. The conditions encountered were unfavorable for a satisfactory pumping plant, and no more wells were put down. At a depth of 58 feet a 4-foot water-bearing sand stratum was encountered from which the water rose 7 feet—that is, to within 51 feet of the surface. No more water was found until the bowlders were encountered at a depth of 365 feet. Water from the bowlder bed rose to the same level as that from the stratum above—that is, to within 51 feet of the surface. No test of the quantity available has been made.

Log of well at Consolidated Canal Company's plant No. 5.

	Feet.
Soil	7
Gravel	5
Yellow clay	12
Sand and gravel	12
White clay	22
Sand, water bearing	6
Packed gravel	22
Cemented sand	24
Clay	8
Cemented sand	6
Clay	4
Gravel	6
Clay	74
Sand	2
Clay	20
Sand	2
Yellow clay	78
Red clay	23
Soft white clay	34
Bowlders	(?)

The material passed through in this well is in marked contrast with that of the neighboring wells. The upper 136 feet has much coarse material, but contains little water. There is thus far little difference in material from the upper 126 feet of the wells at No. 3, about 3 miles to the north. In the wells at No. 3 water-bearing bowlders occur from the 126-foot level down to 262 feet, where clay is encountered. In the wells at No. 5 clay begins at the 134-foot level and extends downward to a depth of 365 feet, where the bowlders are encountered. Here, then, is a case where a bowlder bed 136 feet thick either pinches out entirely, giving place to clay within a distance of about 3 miles, or inclines downward 239 feet in this distance.

PLANT NO. 6.

About 1 mile east of pumping plant No. 1 a dug well 58 feet deep contains water in sufficient quantity to warrant the establishment of a pumping plant. It is said that in digging this well a hard layer of cement was encountered at a depth of a little less than 58 feet. When this was broken through the water at once rose 16 feet in the open well—that is, to within 42 feet of the surface. This well is in slightly higher ground, but the water level is practically the same as that in the wells 1 mile to the west, at pumping plant No. 1. The water beneath the cement layer is probably the same as that encountered in the wells of plant No. 1 at a depth of 36 and 42 feet, respectively, and in the wells 2 miles to the south at 50 feet deep. In the deep wells this water-bearing sand was found to be from 3 to 10 feet thick, and to contain a large amount of water.

The analysis indicates that this water is completely separated from the water in the bowlder bed beneath. Two characteristics are worthy of special notice—the absence of sulphate of lime and the presence of a large amount of black alkali. In these respects the water is in marked contrast with that found only 36 feet below, which has much sulphate of lime and no black alkali.

Analysis of water from well at Consolidated Canal Company's plant No. 6.

Quantitative (parts in 100,000):	
Total solids soluble at 110° C	103.20
Chlorine in terms of NaCl (common salt)	48.80
Hardness in terms of $CaSO_4$ (sulphate of lime)	.00
Alkalinity in terms of Na_2CO_3 (black alkali)	7.63
Nitrogen in the form of nitrates	.21
Nitrogen in the form of nitrites	.0094
Qualitative:	
Sulphates	Strong.
Magnesia	Distinct.
Lime	Distinct.
Carbonates	Slight.

PLANT NO. 7.

A well has been drilled at the power house of the Consolidated Canal Company, 2 miles northwest of Mesa, for the purpose of obtaining water for use at the engine house. It is a 15-inch double-steel-cased well, and is 68 feet deep. The upper 14 feet is an admixture of sand, silt, and bowlders of the recent river deposit. Below this a cemented bowlder bed occurs and continues unchanged to the bottom of the well. The bowlder bed is probably the same as that represented in the edge of the mesa at that point. The well is but a few feet from the bluff represented in Pl. IV, *A*.

Log of well at Consolidated Canal Company's plant No. 7.

	Feet.
Sand, silt, and gravel	14
Cemented bowlders	54

A. EDGE OF THE MESA NEAR CONSOLIDATED CANAL COMPANY'S POWER PLANT.

B. A. J HANSEN'S PUMPING PLANT.

Discharging 518 inches of water.

SEEPAGE WELL.

A seepage well was constructed near the power house of the Consolidated Canal Company, under the direction of W. H. Code, who has described it in the report previously referred to.[a]

The plant is not now in operation. Mr. Code's description and figure are here transcribed because of their bearing upon the quantity of water obtainable from surface gravels near the river.

The writer has had some experience in the sinking of open wells in Salt River Valley, which may be of value to some horticulturists or farmers who contemplate a similar work. To a man who has not had actual experience with the bowlder and quicksand strata encountered in digging wells in this vicinity, the mere excavation of an open well may seem ordinarily easy.

The Consolidated Canal Company decided to investigate the underground water supply in the vicinity of their water-power plant near Mesa, Ariz. Since it was to be simply an experimental well, it was thought best to construct it in the least expensive manner possible. With this end in view a contract was given to some miners to sink a well as deep as we should desire, at a stipulated price per linear foot in depth, we to keep the water out of their way and also to furnish the lumber for cribbing the well. The miners proceeded in the manner common in the sinking and timbering of mining shafts, and we kept the water out of their way as per contract. The natural elevation of the ground water was 7 feet below the surface level at the point selected, and for this distance the excavation was in earth. From this depth on the formation was alternate layers of quicksand and bowlders. The well was 8 by 16 feet, inside measurement, and by dint of perseverance in the face of many obstacles, we sunk it to a depth of 23 feet below the normal level of the water. It is needless to enter into detail concerning the trouble and expense connected with sinking this kind of a well through the material above mentioned to a depth sufficient to give a maximum flow of 4 cubic feet per second (160 miner's inches). We were taught by this experience how not to sink open wells, for although this one is still in fair condition after a service of several years, we know it is not a permanent structure.

After the well was sunk as deep as we deemed practicable, the writer made some observations as to the effect of the steady pumping of 3.75 cubic feet per second (150 miner's inches) on the water levels of adjacent wells. Pits were sunk at varying distances from the large central well, and careful levels were taken of the surface of the water in each well previous to the test run, the elevations being found practically the same. The pump was started in the central well and discharged a constant stream of 3.75 cubic feet per second for one hundred and four hours, near the end of which time levels were again taken of the water in the various sumps. The sketch herewith submitted shows the result of the experiment (fig. 9). It will be seen that the water in the large well pumped from was lowered to a depth of 17.68 feet below normal level. No. 1, distant 55 feet, to a depth of 6.76 feet below normal level; No. 2, distant 90 feet, to a depth of 5.94 feet below normal level; No. 3, distant 118 feet, to a depth of 4.90 feet below normal level; No. 4,

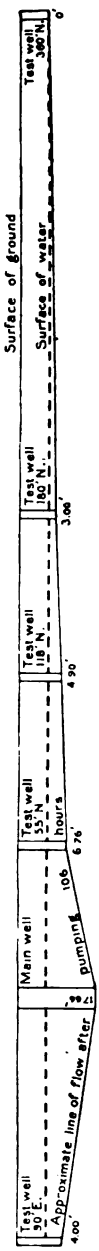


FIG. 9.—Water levels before and after pumping from seepage well of Consolidated Canal Company.

[a] Code, W. H., Report of irrigation investigation for 1900, No. 2: U. S. Dept. Agric., Bull. 104, 1901, pp. 94-96, fig. 14.

distant 180 feet, to a depth of 3.50 feet below normal level; and No. 5, distant 360 feet, to a depth of 1 foot below normal level.

It will be noted that the sump at a distance of 360 feet from the main well was lowered a depth of about 1 foot and that the steepest cone of depression was that between the main well and the test hole No. 1.

OLSEN WELLS (SEC. 18, T. 1 S., R. 5 E.).

Mr. E. Olsen's pumping plant is situated about 6 miles southwest of Mesa. There are five 12-inch double-steel-cased drilled wells, 212 feet deep, placed 30 feet apart. A central shaft sunk to water level communicates with the wells as in the pumping plants previously described. A 12-inch horizontal centrifugal pump is placed near the bottom of the shaft and operated by steam power from above. When run at ordinary speed the pump is said to discharge 375 inches of water (4,219 gallons) per minute. The wells yield this amount readily, the action of the pump lowering the water only 8 feet below the normal level.

Log of E. Olsen's well.

	Feet.
Sandy soil with bands of cement	46
Clay	2
Coarse gravel and bowlders, water bearing	82
Sand	4
Clay	12
Coarse gravel	14
Sand	10
Sand and gravel	6
Clay	24
Sand	12

The principal water-bearing stratum was encountered at a depth of 48 feet and is 82 feet thick. The water from this stratum rises to a level 19 feet below the surface of the ground. This level, however, varies somewhat at different times. On February 1, 1903, measurements were made to determine the amount of the lowering of the water level caused by the pump. On April 14, 1903, measurements were again made under the same conditions, the quantity of water discharged by the pump being the same in each case, 4,219 gallons per minute. The water level at the time of the first measurement was 2 feet lower than at the time of the second measurement. The normal water level, indicated by the elevation of the water when the pumps were not running, had also risen about 2 feet during this time. This variation of water level seems to be due to an annual change, although observations have not extended over a sufficient length of time for determination.

The analysis of water from Mr. Olsen's wells indicates a large content of salts. The sodium carbonate or black alkali, which is most harmful, is, however, absent. The sulphate of lime is harmless, and

the common salt, although very abundant, could be washed out of the soil with comparative ease should it accumulate in too large quantities. The nitrates, so valuable in irrigation, are abundant. It is possible, as many believe, that the continued use of so saline an irrigation water for a series of years will prove harmful to the land, unless precautions are taken to prevent the accumulation of salts in harmful quantities. The quantity and kind of salt which may be present in irrigation waters depend so largely upon the physical and chemical composition of the land irrigated and upon the manipulation of that land that prediction is useless without a more extended knowledge of facts.

Analysis of water from E. Olsen's well.

Quantitative (parts in 100,000):	
Total solids soluble at 110° C	381.00
Chlorine in terms of NaCl (common salt)	235.20
Hardness in terms of $CaSO_4$ (sulphate of lime)	59.84
Alkalinity in terms of Na_2CO_3 (black alkali)	.0
Nitrogen in the form of nitrates	2.00
Nitrogen in the form of nitrites	Faint.
Qualitative:	
Sulphates	Very strong.
Magnesia	Strong.
Lime	Very strong.
Bicarbonates	Very strong.

HANSEN WELLS (SEC. 35, T. 1 S., R. 4 E.).

Mr. A. J. Hansen's pumping plant is located about 10 miles south of Tempe. There are four 12-inch drilled wells, double-steel cased, 30 feet apart, and sunk to a depth of 200 feet. A central shaft containing a 12-inch horizontal centrifugal pump is sunk to water level. From this shaft tunnels communicate with the wells as explained for the Murphy-McQueen plant, and the wells are connected by a horizontal suction pipe. The pump is operated at the surface by steam power, connected by belt to the pump.

No satisfactory tests have been made on the capacity of the plant. The best measurements obtainable indicate a yield of about 518 inches (see Pl. IV, *B*), or something over 5,000 gallons of water per minute. Mr. Hansen is preparing to irrigate, in this way, his entire tract of something over 1,100 acres. At the present writing about 500 acres are supplied with pumped water.

When the pump is run at full speed, drawing from the four wells alike, the water level in the wells is lowered 9 feet 3 inches, making the total lift 26 feet 3 inches. When the water is drawn entirely from an end well, the others being shut off, the water level in that well is said to lower 18 feet, while in the well 90 feet distant it lowers 5 feet. The effect on the intervening wells was not determined.

In drilling the wells very little surface water was encountered, but at a depth of 76 feet water-bearing gravels and bowlders were encountered, from which the water rose 53 feet—that is, to 17 feet below the surface of the ground.

Log of A. J. Hansen's wells.

	Feet.
Soil, sand, and cement	72
Hard cement	4
Coarse sand, gravel, and bowlders, water bearing	124

In the course of the drilling two circumstances were noted indicating the looseness of the water-bearing gravels. In drilling the last well it was noted that the water in the first one, 90 feet distant, moved in unison with the plunge of the sand pump. As the sand bucket, with its massive attachments, descended, the water surface in the first well was agitated and moved slightly upward. As the sand bucket was withdrawn the water surface was lowered slightly, maintaining a churning motion in unison with the drill. The second circumstance was noted in connection with sinking the casing. The casing is usually forced downward under heavy pressure by means of hydraulic jacks into the hole made by the sand pump. In Mr. Hansen's wells the gravels were so loose that the casing settled into them of its own weight and had to be held back to prevent it from settling faster than desired.

Three analyses have been made of water from these wells, the first taken January 2, 1903, and the second March 2, 1903, before any extensive pumping had been done. A third analysis was made May 14, 1904, after the pump had been in constant operation for about five months.

Analyses of water from A. J. Hansen's wells.

	No. 1.	No. 2.	No. 3.
Quantitative (parts in 100,000):			
Total solids soluble at 110° C	509.0	446.8	442.0
Chlorine in terms of NaCl (common salt)	355.0	307.0	311.0
Hardness in terms of $CaSO_4$ (sulphate of lime)	60.9	135.4	151.2
Alkalinity in terms of Na_2CO_3 (black alkali)	.0	.0	.0
Nitrogen in the form of nitrates		Faint.	Trace.
Nitrogen in the form of nitrites		Faint.	.01
Qualitative:			
Sulphates	Very strong.	Very strong.	Very strong.
Magnesia	Very strong.	Very strong.	Strong.
Lime	Very strong.	Very strong.	Very strong.

TEMPE CANAL COMPANY'S WELLS (SEC. 19, T. 1 N., R. 4 E.).

The Tempe Canal Company has undertaken the construction of a large pumping plant, designed to augment the water supply of the Tempe canal. A battery of ten 15-inch wells is planned. Two of these are completed at the present writing. The wells are 50 feet apart, and will be operated from a central station. It is expected that the ten will yield 1,000 inches of water. It is the purpose of the company to increase the output to 3,000 inches, if water is found in sufficient quantity to warrant such expansion.

The pumps will be so placed as to discharge the water into the Tempe canal, thus mixing the pumped water with the river water and distributing it uniformly.

The material encountered in these wells differs notably from that in neighboring wells in the absence of the great number of bowlders. The material is described as sand and gravel rather than as gravel and bowlders, as in other wells, and the lower 33 feet is clay.

Log of Tempe Canal Company's wells.

	Feet.
Soil	10
Sand and gravel	157
Clay	33

VALLEY SEEDLESS GRAPE COMPANY'S WELLS (SEC. 4, T. 1 S., R. 4 E.).

The company's vineyard is situated about 4 miles south of Tempe. There are two 12-inch drilled wells, one at the southern end of the vineyard, 348 feet deep, and one at the northern end, 250 feet deep. In the 250-foot well water-bearing gravels were encountered at a depth of about 190 feet. The water from the gravel bed rose to a level 18 feet below the surface of the ground. The 348-foot well is on higher land and the water level is 30 feet below the surface. No careful driller's record was kept, but the foreman in charge reported that the material passed through was a mixture of sand, clay, and cement to a depth of about 120 feet. At this depth sands and gravels begin and alternate with granitic wash to a depth of about 300 feet. No water worthy of mention was found until a bed of gravel 9 feet thick was encountered at a depth of about 275 feet. Below the 300-foot level the material is granitic wash down to 340 feet, where hard red granite was found. The well penetrates the granite 8 feet.

The 250-foot well is not in use at the present time. The 348-foot well is operated to irrigate the vineyard by a centrifugal pump placed in a shaft sunk to near water level and operated by a 12-horsepower gasoline engine. The water is pumped into a small cement reservoir from which it is distributed for irrigation.

Repeated efforts were made to secure measurements in a test run of this plant for the purpose of computing the cost of water thus obtained. In the meantime Prof. S. M. Woodward, of the Arizona Experiment Station, working independently to the same end, obtained measurements which he has kindly allowed me to use. The test run consumed 1.5 hours, the quantity of water pumped during that time being measured in the cement reservoir and the rate per second computed. The water in the well was lowered 11.5 feet when the pump started and remained constant during the run. The water was lifted 5.5 feet above the level of the ground, making a total lift of 47 feet. The plant is still in an experimental stage and certain easily remedied faults in construction will reduce the cost given below. Owing also to these imperfections, the liability to error in measurements is needlessly great. Those taken by Professor Woodward are probably as accurate as can be obtained at the present time. The original cost of the plant could not be obtained and attendance is not included in the following computations:

Cost of pumping water at the Valley Seedless Grape Company's vineyard.

Rate of discharge in cubic feet per seconds	1.15
Distillate consumed per hour, in gallons	1.6
Time to pump 1 acre-foot, in hours	10.52
Distillate consumed per acre-foot of water pumped, in gallons	16.83
16.83 gallons of distillate, at 22 cents	$3.70
Oil and incidentals	$0.05
Total cost per acre-foot	$3.75
Lift in feet	47
Average cost per foot in raising an acre-foot	$0.08

Analyses of water from the Valley Seedless Grape Company's wells.

	348-foot well.	250-foot well.
Quantitative (parts in 100,000):		
Total solids soluble at 110° C	155.8	115.2
Chlorine in terms of NaCl (common salt)	105.4	78.6
Hardness in terms of $CaSO_4$ (sulphate of lime)	21.8	11.4
Alkalinity in terms of Na_2CO_3 (black alkali)	.0	.0
Qualitative:		
Sulphates	Strong.	Strong.
Magnesia	Pronounced.	Pronounced.
Lime	Strong.	Strong.

TEMPE WATERWORKS WELLS.

The town of Tempe is supplied with water from three 12-inch double-steel-cased wells, 152 feet, 147 feet, and 145 feet deep, respectively. The water-bearing gravels were entered at a depth of 12 feet

A. TEMPE BUTTE, SHOWING RESERVOIR NEAR THE TOP.

B. COLLINS WELL, NEAR PHOENIX.

and the surface of the water at 23 feet. The water is under no pressure and is not capped by an impervious clay, as it is in most places throughout the valley.

The plant is a well-equipped one, with a shaft 20 by 20 feet, sunk 15 feet, and containing a Goulds triplex single-acting pump and 30-horsepower electric motor. The three wells are connected by a horizontal suction pipe, from which a vertical suction pipe extends into each well, inside the casing. The water is forced to a reservoir near the top of Tempe Butte, making a total lift of 249 feet. (Pl. V, *A*.)

It is especially worthy of note that at Tempe the water-bearing gravels extend practically to the surface, the shallow wells reaching the same water body from which the deep wells draw. This is not the case 1 mile south of Tempe at H. L. Chandler's well, where the surface waters are separated from the waters of the great bowlder bed by impervious clay. Analyses of water from the deep wells and from shallow wells near by indicate the same kinds of salts in both the shallow and deep wells, but show varying amounts. The following analyses are from wells only a few blocks apart. The town well is perforated only below 90 feet, and the water analyzed from this well is presumably from that depth. The others are from wells about 30 feet deep.

Log of Tempe waterworks well.

	Feet.
Surface soil	4
Clay and bowlders	6
Clay, sand, and bowlders, cemented	2
Loose sand, gravel, and bowlders, water bearing	117
Igneous rock	23

Analyses of water from wells at Tempe, Ariz.

	City waterworks; 152 feet.	Casa Loma Hotel.	Normal School; 30 feet.
Quantitative (parts in 100,000):			
Total solids soluble at 110° C	103.0	169.8	219.2
Chlorine in terms of NaCl (common salt)	58.8	105.8	133.6
Hardness in terms of $CaSO_4$ (sulphate of lime)	9.52	12.9	15.78
Alkalinity in terms of Na_2CO_3 (black alkali)	.0	.0	.0
Nitrogen in the form of nitrates	.17	.18	.51
Nitrogen in the form of nitrites	.0	.0027	.0
Qualitative:			
Sulphates	Strong.	Very strong.	Very strong.
Magnesia	Strong.	Pronounced.	Very strong.
Lime	Strong.	Very strong.	Very strong.

At the request of the writer, Mr. P. E. Fuller, the engineer under whose direction the pumping plant was constructed, made a careful test of the quantity of water pumped, power consumed, etc. Mr. Fuller has been kind enough to put the observations in the tabular form given below:

Test of pumping plant of Tempe city waterworks, August 2, 1903.

READINGS.

Time.	Voltage between phases.	Total amperes.	Pressure gage.	Vacuum.	Watt meter, one phase.	Revolutions of pump; 6¼ gallons per revolution.	Velocity watt meters per minute.	Difference between gages.
			Pounds.	*Inches.*				
4.20[a] ..	175.0	170	99	15.25	1,747,200	810.310	37.00	3.33
4.40....	177.5	170	99	15.25	1,747,700	811.221	.....	3.33
4.50....	182.5	170	99	15.25	1,748,050	811.623	34.50	3.33
5.....	172.5	170	99	14.75	1,748,320	812.056	34.50	3.33
5.10....	165.0	170	99	14.75	1,748,580	812.487	35.50	3.33
5.20[b] ..	152.5	172	99	14.50	1,748,830	812.848	33.50	3.33
Total.	170.83	170.33	99	14.96	1,630 kw.	2,538 rev.	35.00	3.33

[a] Running start was made; watt meter was 37.3 per cent fast, volt meter was 1 per cent low—for all readings of watts and voltage.
[b] Low readings due to low voltage at power house.

DEDUCTIONS.

Average voltage corrected for error		172.55
Average amperes in both phases		170.33
Apparent energy consumed by motor	kilowatts..	29.39
Actual energy consumed	do...	23.51
Power factor	per cent..	80.00
Horsepower actually consumed by motor		31.51
Average gallons of water pumped per minute		274.95
Total head, in feet, pumped against		248.87
Net water horsepower		18.49
Combined efficiency of motor, pump, suction piping, and ¾-mile 8-inch main	per cent..	58.68
Power rate paid per thousand gallons pumped	cents..	4
Equivalent cost per horsepower per hour and per kilowatt per hour	do...	2.13 2.85

Reducing the figures to the basis of cost per acre-foot of water lifted, we have the following:

Cost of pumping water at the Tempe, Ariz., waterworks.

Cost of plant (not including the reservoir and distributing system)	$3,700.00
Interest on investment at 7 per cent per annum for 19.8 hours	$0.59
Depreciation at 10 per cent per annum for 19.8 hours	$0.84
Hours to pump 1 acre-foot	19.8
Cost of power to raise 1 acre-foot (power furnished at 4 cents per 1,000 gallons of water pumped)	$13.07
Oil and incidentals (estimated)	$0.05

Total cost per acre-foot	$14.55
Total lift in feet	249
Average cost per foot in lifting 1 acre-foot of water	$0.058

CHANDLER WELL (SEC. 21, T. 1 N., R. 4 E.).

Mr. H. L. Chandler proposes to establish a pumping plant for irrigation about 1 mile south of Tempe. Two 12-inch double-steel-cased wells were started, but accidents have caused a discontinuance of the work. One well, however, reached a depth of 186 feet, and the record, furnished by the driller, is given herewith. The well is in water-bearing gravels and bowlders throughout nearly the entire depth. There seem, however, to be two distinct bodies of bowlders separated by 8 feet of clay. The upper or surface water is alkaline, from which the lower water is probably free, as is the case in other wells of the region. The lower water was struck at a depth of 41 feet below the surface. An unusually large number of heavy bowlders were encountered in these wells, making the drilling a matter of some difficulty, but at the same time indicating a comparatively free passage for the underflow. It is in the beds of coarse gravels and bowlders that the greatest available quantity of water is to be expected.

Log of H. L. Chandler's well.

	Feet.
Soil and cement	11
Gravel and bowlders, water bearing	22
Clay	8
Gravel and bowlders, water bearing	145

A sample of the water was taken for analysis from near the bottom of the well, the water being obtained from the sand pump as the bucket was hoisted. The sample is not therefore representative of the water at this locality. The alkali is probably from water of the upper stratum. Samples of water taken in this way from other wells which were afterwards cleared by pumping show a greater proportion of salts than samples taken after pumping. The analysis, however, is here given for the sake of completeness and for the purpose of indicating something of the quantity of salts contained in the waters of this locality.

Analysis of water from H. L. Chandler's well.

Quantitative (parts in 100,000):	
Total solids soluble at 110° C	224.00
Chlorine in terms of NaCl (common salt)	146.00
Hardness in terms of $CaSO_4$ (sulphate of lime)	.00
Alkalinity in terms of Na_2CO_3 (black alkali)	2.12
Qualitative:	
Sulphates	Very strong.
Magnesia	Very strong.
Lime	Strong.

This well was utilized to some extent during the summer of 1904. A solar motor, established temporarily, for the past four months has pumped 350 to 380 gallons of water per minute during the hours of sunshine.

FLUMMERFELT WELL (SEC. 11, T. 1 S., R. 4 E.)

Mr. Bristol Flummerfelt has a 6-inch drilled well 61 feet deep. The surface water at his place proved unsatisfactory both in quantity and quality, and his object in drilling was to obtain a supply for domestic use. A solid casing was used to shut off the surface water and the well was put down only 6 feet into the gravels, since all the water needed was obtained at that depth. The quantity and quality of the water from the 55-foot level indicate that it comes from the body encountered as the second horizon in the deeper wells of the same region.

Log of Bristol Flummerfelt's well.

	Feet.
Soil	10
Cement, with sand and gravel	30
Clay	15
Gravel and bowlders, water bearing	6–

Analysis of water from Bristol Flummerfelt's well.

Quantitative (parts in 100,000):	
Total solids soluble at 110° C	186.00
Chlorine in terms of NaCl (common salt)	122.00
Hardness in terms of $CaSO_4$ (sulphate of lime)	13.60
Alkalinity in terms of Na_2CO_3 (black alkali)	0.00
Qualitative:	
Sulphates	Strong.
Magnesia	Strong.
Lime	Very strong.
Bicarbonates	Very strong.

BARTLETT-HEARD LAND AND CATTLE COMPANY'S WELLS.

D. B. Heard has sunk two wells south of Tempe. The first is 1,000 feet west of the railroad and the second about 2,000 feet east of the railroad. Both are 15-inch double-steel-cased wells, the first 259 feet deep and the second 217 feet. Water was not obtained in satisfactory quantities in either well; the first yielding practically none and the second too little to warrant the establishment of an extensive pumping plant such as was planned. These wells were therefore practically abandoned, and the plant is to be established farther to the west as described elsewhere.

In well No. 1, sunk 1,000 feet west of the railroad (sec. 4, T. 1 S., R. 4 E.), gravels and bowlders were encountered similar to those in other wells of the vicinity, except that they were cemented together

with caliche allowing little water to pass among them. The well is 1,000 feet west of one of the wells at the Valley Seedless Grape Company's vineyard which yields a good supply of water. At this point therefore the line marking the zone of abundant underground water is to be drawn between these wells.

Log of Bartlett-Heard well No. 1.

	Feet.
Soil and cement	34
Gravel	6
Cemented wash	83
Cemented bowlders	136

Well No. 2, sunk 2,000 feet east of the railroad (sec. 3, T. 1 S., R. 4 E.), was found somewhat more promising than the first but the available quantity of water was limited. The material passed through was almost entirely fine wash cemented by caliche; bed rock was struck at a depth of 217 feet. Well No. 2 is farther from the Salt River Mountains by 3,000 feet than well No. 1. It is furthermore in the direction in which, judging from records of other wells, favorable conditions for a satisfactory water supply are naturally expected; yet the well penetrates very little water-bearing material and reaches granite at the bottom.

Log of Bartlett-Heard well No. 2.

	Feet.
Soil and cement	22
Cement, water in pores	14
Cement	30
Bowlders and clay	6
Clay and cement	38
Gravel, water bearing	6
Clay and cement	36
Cement	4
Clay	8
Cement	6
Clay	16
Cement	4
Clay	10
Granitic wash	17
Bed rock	?

JOHNSON WELL (SEC. 30, T. 1 N., R. 5 E.).

Mr. B. F. Johnson has a shallow well 10 by 6 feet and 33 feet deep with 10 feet of water, from which he is pumping about 150 inches of water, using an 8-inch centrifugal pump and a 30-horsepower gasoline engine. The well yields this amount of water readily, the water being lowered by the pump only 3.5 feet.

The available quantity of water seems to warrant more extensive development. Two 12-inch double-steel-cased wells have been drilled and the installation of the pumping plant is in progress. The wells

are 180 feet deep, and penetrate the gravel and bowlders common in that region. It is worthy of note that clay and granitic wash were found beneath the bowlders.

Log of well of B. F. Johnson, near Mesa, Ariz.

	Feet.
Soil	10
Sand, gravel, and bowlders	125
Clay	37
Granitic wash	8

TEMPE-MESA PRODUCE COMPANY'S WELL (SEC. 23, T. 1 N., R. 4 E.).

The company has recently established a pumping plant at its creamery near Tempe. There is one 12-inch double-steel-cased well 100 feet deep. As indicated in the log it is in loose gravel and bowlders through practically the whole depth.

Log of Tempe-Mesa Produce Company's well.

	Feet.
Soil	10
Gravel and bowlders	90

DESERT WELL (SEC. 11, T. 1 S., R. 7 E.).

This well is located about 15 miles southeast of Mesa, on the road leading from Mesa to Florence, and is owned at the present time by Thomas Buchanan. The well, which was dug in 1885, is 212 feet deep and contains 24 feet of water. On a platform near the surface of the water is a pump and small steam engine, supplied by steam generated above ground, which lifts water at the rate of 25 gallons per minute. The surface of the water is lowered 10 feet by the pump, at which stage the inflow equals the demand of the pump.

Log of Desert well.

	Feet.
"Wash" (sand, pebbles, clay, and cement)	150
Sand	2
Cement	20
Sand and gravel	5
Cement	?
Water-bearing gravel	?

The material penetrated in digging the well varies little in the 188 feet exposed above the water. The sides are not cased, except in three places where loose sand was encountered. The material is "wash" from the hills. It is an intimate admixture of clay, sand, and pebbles more or less cemented in places by caliche. The pebbles are angular and give slight indication of the action of water. Although the sides of the well are not protected in any way, they have stood for eighteen years without material change. Little moisture reaches them from the surface, and no water-bearing seams were encountered until near the

bottom. At a depth of 212 feet a cement layer was penetrated and water encountered under sufficient pressure to raise it 24 feet.

Mr. Buchanan reports that the water has been steadily rising in the well for eight years—ever since he has owned the well. Even during the exceptionally dry years of 1901 and 1902, when many of the shallower wells of the valley entirely failed, the water in Desert well steadily increased in volume. This increase is somewhat vividly indicated by the present position of the engine and pump in the well. When placed there the platform upon which they rest was built at a convenient distance above the surface of the water. At the time of my visit the water was 3 feet deep over the platform and the engine and pump were submerged.

The quantity of water does not appear to be such as to warrant the supposition that this well draws from the great gravel beds furnishing the principal flow in the wells farther west. Twenty-five gallons per minute is a small volume compared with that yielded by some of the wells, and yet this yield lowers the water in Desert well about 10 feet. The quality of the water as shown by the following analysis and the elevation of the water 1,260 feet as against 1,134 in the Murphy-McQueen well renders it probable that the stratum from which the desert well draws its supply is connected with what is known as the surface flow of the valley rather than with the deeper and larger flow. In order to strike the level of the water-bearing gravels which supply the water for the large pumping plants of the valley Desert well would have to be lowered about 100 feet.

Analysis of water from Desert well.

Quantitative (parts in 100,000):	
Total solids soluble at 110° C	32.00
Chlorine in terms of NaCl (common salt)	5.20
Hardness in terms of $CaSO_4$ (sulphate of lime)	.00
Alkalinity in terms of Na_2CO_3 (black alkali)	4.66
Nitrogen in terms of nitrates	.494
Nitrogen in terms of nitrites	Very faint.
Qualitative:	
Sulphates	Faint.
Magnesia	Very faint.
Lime	Faint.
Bicarbonates	None.

KLEINMAN WELL (T. 2 S., R. 9 E.).

Mr. Daniel Kleinman's well is about 10 miles southeast of Desert well and 25 miles southeast of Mesa, on the Mesa-Florence road. It was dug to a depth of 272 feet, and from the bottom a 14-inch pipe was driven 12 feet, making the total depth 284 feet. The log of the well could not be obtained. The quantity of bowlders taken from the well, however, indicates that bowlder and gravel beds make up a large

part of the material passed through. These bowlders have a maximum diameter of something over 1 foot and are thoroughly water worn. They are composed of quartzite and several varieties of granitic rock, together with gneisses and schists, in about the same proportion as they are found in the river bed at the present time.

The water flows from the top of the pipe into the open well, where it stands 2.5 feet deep. It is pumped by horsepower. A team of horses working continuously raises on an average 12.5 gallons per minute.

BOWEN WELL (T. 2 S., R. 9 E.).

Mr. Robert Bowen's well is situated near the south bank of Queen Creek, about 1 mile west of the point where the Florence-Mesa road crosses Queen Creek. The well is dug 212 feet deep and contains 2.5 feet of water. Although the water is so shallow there seems to be no possibility of exhausting it by the means at hand. The well is supplied with both windmill and horsepower for pumping and about 9 gallons per minute may be raised, a yield which does not lower the water level in the well to any appreciable extent. The water is said to show a distinct current flowing toward the west. Floating material gathers at the west side of the well. A float placed at the east side is said to traverse the diameter of the well 4 feet in about three minutes.

The material passed through is nearly all loose gravel and bowlders. The water is not confined by a clay or cement layer, but seems to mark the free surface of the underflow of Queen Creek.

Log of Robert Bowen's well.

	Feet.
Soil	8
Sand, gravel, and bowlders	25
Soft clay	6
Sand, gravel, and bowlders	50
Soft clay	2
Sand, gravel, and bowlders	24
Soft clay	26
Sand, gravel, and bowlders with streaks and bands of clay from a few inches to 2 feet thick	70

Analysis of water from Robert Bowen's well.

Quantitative (parts in 100,000):	
Total solids soluble at 110° C	54.00
Chlorine in terms of NaCl (common salt)	24.00
Hardness in terms of $CaSO_4$ (sulphate of lime)	16.30
Alkalinity in terms of Na_2CO_3 (black alkali)	.00
Qualitative:	
Sulphates	Distinct.
Magnesia	Distinct.
Lime	Strong.
Bicarbonates	Strong.

HARRINGTON WELL (SEC. 2, T. 2 S., R. 8 E.).

This well, which is owned at the present time by José Granillo, is dug 135 feet deep, and contains about 4 feet of water. No log could be obtained. The well was dug in 1892. The water is raised by horsepower with barrel and rope, and is used for stock and for the traveling public.

ANDRADA WELL (T. 2 S., R. 7 E.).

Sylvester Andrada's well is dug 114 feet deep, and had 14 feet of water when measured. The well, which is used somewhat extensively for watering stock, is provided with a small traction engine and pump. A large cement and cobblestone tank, about 20 feet square and 6 feet deep, serves as a reservoir. The capacity of the pump could not be ascertained, but is not great. When the pump is in operation the water is said to lower about 7 feet, and remains at that level until the pump stops, when the water soon regains its former level. The water is soft, and, judging from taste, contains little salt of any kind.

PRICE WELL (SEC. 11, T. 1 N., R. 4 E.).

Col. J. A. Price has a well 15 feet deep, in which the water was found in the loose gravel and bowlders of the recent river accumulations. Until the plant was burned a few years ago, he pumped it for irrigation continuously at the rate of about 600 gallons per minute, obtaining water at this rate during the dryest times; ordinarily it might have yielded a greater amount.

PARRY WELL (SEC. 14, T. 1 N., R. 4 E.).

Mr. T. J. Parry's well is dug about one-fourth mile south of the river and 1 mile east of Tempe. It is about 40 by 60 feet and 21 feet deep, the water standing 17 feet below the surface of the ground. The level, however, varies with the water in the river; when there are floods in the river the water in the well rises, water marks on the sides of the well indicating that variations of at least 4 feet occur. It is said that the water in the well begins to rise about two days after the crest of the flood has passed.

Water is lifted by means of a 6-horsepower gasoline engine and bucket pump. When run at ordinary speed, the pump discharges 673 gallons per minute. It is operated about six hours a day; a run of four hours in the morning drains the well, but toward evening enough water has accumulated for a two-hour run. The well penetrates only a few feet beneath the water-bearing sands and gravels and is not cribbed or otherwise protected. If sunk a few feet deeper it would undoubtedly yield a much larger and more constant supply.

This plant offered a good opportunity of testing the cost of raising water by means of a bucket pump and gasoline engine. The amount of gasoline was accurately measured and the quantity of water computed from the average number of buckets lifted. (It was found later that owing to a defective valve more gasoline may have been used than was necessary.)

Cost of pumping water at T. J. Parry's pumping plant.

Cost of well (estimated)	$400.00
Cost of engine and pump	$500.00
Interest on investment, at 7 per cent per annum for 8.1 hours	$0.06
Depreciation, at 10 per cent per annum for 8.1 hours	$0.08
Amount of water lifted in 1 hour, in gallons	40,320
Hours required to lift 1 acre-foot	8.1
Gallons of gasoline used in 1 hour	1.2
Gallons of gasoline used in 8.1 hours	9.72
9.72 gallons, at 28 cents	$2.72
Oil, etc. (estimated)	$0.05
Total cost per acre-foot	$2.91
Total lift, in feet	18
Average cost per foot in lifting 1 acre-foot of water	$0.161

JENKINS SEEPAGE DITCH (SEC. 20, T. 1 N., R. 4 E.).

Mr. A. R. Jenkins has a seepage ditch southwest of Tempe. The ditch heads into the area east of Bell Butte, where the underground water surface is at a depth of about 8 feet. It has a maximum depth of 10 feet, thus penetrating the water-charged gravels about 2 feet at the deepest point. Water seeps into the ditch for about one-fourth of a mile, and yields at present about 30 inches. When the ditch was first constructed the underground water stood within 2 feet of the surface, but during the last few years the surface of the underground water throughout this region has been lowering.

The ditch was constructed in 1895 and the land irrigated from it has had little other water since that time. The water is derived from the surface flow south of Tempe and contains the black alkali which is so much feared by the farmers of that region. Mr. Jenkins reports no ill effects to the land from the use of this water, although it has been used almost exclusively for eight years.

Two analyses of water from this ditch show salts as follows:

Analyses of water from A. R. Jenkins's seepage ditch.

	No. 1.	No. 2.
Quantitative (parts in 100,000):		
Total solids soluble at 110° C	189.4	216.4
Chlorine in terms of NaCl (common salt)	136.0	142.9
Hardness in terms of $CaSO_4$ (sulphate of lime)	.0	.0
Alkalinity in terms of Na_2CO_3 (black alkali)	8.4	7.7
Qualitative:		
Sulphate	Very strong.	Strong.
Magnesia	Strong.	Faint.
Lime	Strong.	Strong.

SHALLOW WELLS.

PHIL METS AND ALHAMBRA HOTEL WELLS.

The well at Mets's livery stable may be taken as a fair representative of the shallow wells at Mesa. A careful record of material passed through is given below. It consists of river drift, composed of sand, pebbles, and bowlders, with a subordinate amount of clay and cement. The bowlders are principally composed of quartz, quartzite, and some of the more resistant granitic rocks and have a maximum diameter of 1 foot or more. They are thoroughly waterworn and differ in no essential respect from the materials found at the present time in the bed of the river. The bands of clay and cement contain sand and pebbles in varying proportions.

Log of P. Mets's well, Mesa.

	Feet.
Sandy soil	13
Gravel and bowlders	7
Cement	1
Coarse sand	9
Hard, sandy cement	3
Sand and gravel	19
Hard cement containing sand and small pebbles	4
Gravel, water bearing	2

Water was first struck in the gravels at a depth of 39 feet. This failed in dry times and the well was lowered, obtaining a better supply a little deeper. This supply diminished in time and the well was again lowered. The process of lowering the well continued until at a depth of 52 feet a hard, impervious cement layer 4 feet thick was encountered. The bar with which this was being dug struck through into a bed of loose gravel containing water under slight pressure. The water quickly rose 6 feet. Since that time there has been no shortage, the

water standing steadily 6 feet deep. A yield of 700 gallons per hour, even in the driest times, has little effect on the amount of water in the well.

The water from the 56-foot level is of somewhat different quality from that of higher levels. The water from the Mets well tastes salty, but is otherwise a more palatable drinking water than that of many of the shallower wells of the vicinity.

An analysis of this water is given below, and also one of water from the well at the Alhambra Hotel, in the adjoining block. The Alhambra supply comes from a horizon a few feet above that of the Mets well, probably above the cement stratum at the bottom of the Mets well. Judged by the taste alone the two waters are very different, but the analyses show them very much alike.

Analysis of water from P. Mets's well and the Alhambra Hotel well, at Mesa.

	Mets.	Alhambra.
Quantitative (parts in 100,000):		
Total solids soluble at 110° C	167.80	152.00
Chlorine in terms of NaCl (common salt)	108.00	89.60
Hardness in terms of $CaSO_4$ (sulphate of lime)	.00	.00
Alkalinity in terms of Na_2CO_3 (black alkali)	9.33	5.51
Nitrogen in the form of nitrates	.385	.33
Nitrogen in the form of nitrites	Very faint.	Very faint.
Qualitative:		
Sulphate	Strong.	Strong.
Magnesia	Faint.	Faint.
Lime	Strong.	Strong.
Bicarbonates	Very strong.	Very strong.

VARIATION IN QUALITY.

The water of the various shallow wells in and about Mesa varies in quality to a marked extent. They are all strongly charged with various soluble salts. A study of the analyses shows that common salt, the carbonates, and the sulphates are the most common and are present in large amount in nearly all the waters, but the variation in the proportions of these salts causes the many varieties of water which arouse so much wonder and speculation in the minds of the owners of the wells. In most of the well waters common salt predominates. Nearly all the well water is said to be hard, and lye is very generally used to "break" it; only a few wells contain water which is said to be soft, though the analyses just given show an absence of any permanent hardness. It is possible that the abundance of other salts in the water renders difficult the detection of hardness by the taste.

Many of the wells are so strong in alkali and the bitter salts that they have been abandoned. In other cases the owners have accustomed themselves to the use of water which a stranger could not safely use. In still other cases the water seems to have gradually improved as the well was used. The published analyses do not indicate the range of variation in chemical character, for the reason that only wells yielding waters sufficiently good to be used are preserved. Many wells have been destroyed which yielded water too alkaline or too bitter for use. In other cases wells yielding bitter or intensely alkaline waters are said to have been greatly improved by pumping. In some cases this reported improvement is no doubt due to the education of the taste rather than to the change in character of the water, but in other cases there seem to be good reasons for believing that wells have entered small pockets containing saline solutions and more or less separated from the main body of underground waters. An exhaustion of the limited supply of such saline solutions would allow the entrance of water from the main water body and would effect a corresponding change in character.

TABULATION OF WELLS.

It seemed advisable in the study of the underground waters of the valley to test the existence of a definite regular water table and to determine the relations of such water table to the land surface and to the river, the principal source of the underground supply. Mesa Township (see Pl. XVIII) was selected for this test on account of favorable location and the existence there of a large number of wells. In the townships bordering Mesa the wells are fewer in number, but with the definite information obtainable from the great number of wells in Mesa Township the water table of the Mesa district is satisfactorily determined and is described in Chapter III.

Tabulation of shallow wells.

MESA TOWNSHIP (T. 1 N., R. 5 E.).

[Records obtained by Robert Muldrow.]

Number.	Owner.	Post-office.	Location.			Completed.	How put down.	Depth of well.	Depth to water.	Does water vary at different times of year?	Is water easily lowered?	Did water rise when struck?	Has the volume of water increased or diminished?	Elevation of surface.	Elevation of water.	Remarks.
			Township.	Range.	Section.											
								Feet.	*Feet.*					*Feet.*	*Feet.*	
347	E. E. Jones	Lehi	1 N.	5 E.	1	1887	Dug	41	40	Yes	Yes	No	Diminished	1,241	1,201	Constantly lowered.
346	Ed. Prothero	do	1 N.	5 E.	1	1890	do	43	42	Yes	Yes	No	do	1,242	1,200	Do.
344		do	1 N.	5 E.	1		do	50	49	Yes		No	do	1,250	1,201	Do.
237	George Rogers	do	1 N.	5 E.	2	1889	do	27	26	Yes	Yes	No	do	1,232	1,206	Do.
238	Charles Davis	do	1 N.	5 E.	2	1884	do	33	30	Yes	No	No	do	1,230	1,200	
239	S. B. Steele	do	1 N.	5 E.	2	1890	do	35	32	Yes	No	No	do	1,230	1,200	
240	J. W. Clark	do	1 N.	5 E.	2	1892	do	35	34	Yes	Yes	No	do	1,233	1,199	Do.
241	C. H. Rollins	do	1 N.	5 E.	2	1902	do	35	34		No	No	Neither	1,234	1,200	
342	Joseph Hawkins	do	1 N.	5 E.	2	1901	do	38	37		No	No	Diminished	1,235	1,198	
343					2		do	33						1,236		Dry.
345	B. Noble	Lehi	1 N.	5 E.	2	1887	do	38	37	Yes	No	No	Diminished	1,234	1,198	Constantly lowered.
348	George Tiffany	do	1 N.	5 E.	2	1900	do	40		Yes	Yes	No	do	1,238		Dry.
349	S. C. Sorenson	do	1 N.	5 E.	2		do	40	39	Yes	Yes	No	do	1,237	1,198	Constantly lowered.
353	Wm. Nelson	do	1 N.	5 E.	2	1898	do	32	31	Yes	No	No	do	1,228	1,197	Do.
354	Ruth Gibson	do	1 N.	5 E.	2		do	31		Yes	No	No	do	1,228		Dry.
356	E. D. Biggs	do	1 N.	5 E.	2	1894	do	33	32	Yes	No	No	do	1,228	1,196	Constantly lowered.
357	Leuella Davis	do	1 N.	5 E.	2	1901	do	30		Yes	No	No	do	1,232		Dry.
361	Thomas E. Jones	do	1 N.	5 E.	2	1902	do	39	37	No	No	No	Neither	1,226	1,199	
363	L. F. Kiggins	Mesa	1 N.	5 E.	3		do	28		Yes	No	No	Diminished	1,221		Do.
362	Harvey Harper	Lehi	1 N.	5 E.	3	1895	do	28	27	Yes	Yes	Yes	do	1,225	1,198	Constantly lowered.
360	D. R. Jones	do	1 N.	5 E.	3	1892	do	30	29	Yes	No	No	do	1,222	1,193	Do.
358	C. G. Shill	do	1 N.	5 E.	3	1902	do	30	29	Yes	Yes	No	do	1,229	1,200	Do.

355	F. J. Davis	do	1 N.	5 E.	3	1898	do	31	30	Yes	No	No	do	1,228	1,198	Do.
352	O. A. Wing	do	1 N.	5 E.	3	1897	do	32	31	No	Yes	Yes	do	1,227	1,195	Do.
302		Mesa	1 N.	5 E.	4		do	8		Yes			do	1,211		Dry.
299	Wm. Schwartz	Lehi	1 N.	5 E.	4	1900	do	27	26	Yes	Yes	No	do	1,220	1,193	
123	Charles Bowers	Mesa	1 N.	5 E.	4		do	26						1,206		Do.
301	E. E. Weller	do	1 N.	5 E.	4	1901	do	20		Yes	Yes	No	Diminished	1,213		Do.
364	Indian	do	1 N.	5 E.	5		do	27	25	Yes		No	do	1,212	1,187	
365	do		1 N.	5 E.	5		do	21	18					1,210	1,182	
382	do		1 N.	5 E.	5		do	27	26					1,215	1,189	
385	do		1 N.	5 E.	5		do	26	25					1,216	1,191	
379	do		1 N.	5 E.	6		do	25	24	Yes	No		Diminished	1,208	1,184	
376	do		1 N.	5 E.	6		do	25	24	Yes	No	No	do	1,210	1,186	
377	do		1 N.	5 E.	6		do	21	20	Yes			do	1,206	1,186	
378	do		1 N.	5 E.	6		do	22	21	Yes	No	No	do	1,210	1,189	
369	do		1 N.	5 E.	6		do	21						1,207		Dry.
380	do		1 N.	5 E.	7		do	18	16				Diminished	1,192	1,176	
387	J. B. Wallace	Tempe	1 N.	5 E.	8	1886	Driven	15	9	Yes	Yes	No	do	1,201	1,192	
388	Wm. Wallace	do	1 N.	5 E.	8	1892	do	15	9	Yes	Yes	No	do	1,202	1,193	
303	E. B. Kearley	Mesa	1 N.	5 E.	8	1895	Dug	22	18	Yes	No		do	1,203	1,185	
300	Frank Sanders	Lehi	1 N.	5 E.	9	1898	do	30	24	Yes	Yes	Yes	do	1,215	1,191	Constantly lowered.
304	J. A. Williams	Mesa	1 N.	5 E.	9	1898	do	23	20	Yes	No	No	do	1,210	1,190	Do.
305	David Wallace	do	1 N.	5 E.	9		Driven									
351	H. Simpkins	Lehi	1 N.	5 E.	11	1902	Dug	36	35	Yes	No	No	Diminished	1,232	1,197	
350	Hannah Williams	do	1 N.	5 E.	11	1902	do	40	39	No	No	No	Neither	1,235	1,196	
333	P. W. Byers	do	1 N.	5 E.	11	1895	do	23		Yes	Yes		Diminished	1,230		Dry.
334			1 N.	5 E.	11		do	25					do	1,226		Do.
335			1 N.	5 E.	11		do	25	24	Yes	Yes		do	1,230	1,206	Constantly lowered.
336	C. W. Simpkins	Lehi	1 N.	5 E.	11	1901	do	20		Yes	No	No	do	1,230		Dry.
372			1 N.	5 E.	12		do	32					do	1,244		Do.
373			1 N.	5 E.	12		do	67	66	Yes	No	No	do	1,263	1,197	
374			1 N.	5 E.	12		do	64					do	1,263		Do.
375			1 N.	5 E.	12		do	64					do	1,282		Do.
122	O. C. Bullock	Mesa	1 N.	5 E.	13	1900	do	51		Yes	Yes	Yes	do	1,244		Do.
314	David Wallace	do	1 N.	5 E.	14	1892	do	54	53	Yes	No	No	do	1,244	1,181	Constantly lowered.
315	Thos. Jensen	do	1 N.	5 E.	14		do	57	55	Yes	No	No	do	1,249	1,184	Do.

Tabulation of shallow wells—Continued.

MESA TOWNSHIP (T. 1 N., R. 5 E.)—Continued.

Number.	Owner.	Post-office.	Location. Township.	Range.	Section.	Completed.	How put down.	Depth of well.	Depth to water.	Does water vary at different times of year?	Is water easily lowered?	Did water rise when struck?	Has the volume of water increased or diminished?	Elevation of surface.	Elevation of water.	Remarks.
								Feet.	*Feet.*					*Feet.*	*Feet.*	
371	A. J. Chandler	Mesa	1 N.	5 E.	14		Dug	26						1,249		Dry.
117	M. A. Crouse	do	1 N.	5 E.	14		do	55	54	No	No	No	Diminished	1,242	1,187	Constantly lowered.
120	D. Drorbaugh	do	1 N.	5 E.	14		do	50	48	Yes	Yes		do	1,243	1,195	Do.
332	J. M. Schule	do	1 N.	5 E.	15	1887	do	57	56	Yes	No	No	do	1,245	1,189	Do.
110	F. P. Drew	do	1 N.	5 E.	15		do	55	52				do	1,242	1,190	
311	Ed Lewis	do	1 N.	5 E.	16		do	61	60	Yes	Yes	No	do	1,246	1,186	Do.
312	M. F. Davis	do	1 N.	5 E.	16	1900	do	62	60	Yes	No	No	do	1,242		Dry.
313			1 N.	5 E.	16	1897	do	52						1,242		Do.
279	O. S. Stapley	Mesa	1 N.	5 E.	16	1900	do	55	54	Yes	Yes	No	Diminished	1,242	1,188	Constantly lowered.
281			1 N.	5 E.	16		do	52						1,240		Dry.
282	L. D. Crook	Tempe	1 N.	5 E.	16	1900	do	57	55	Yes	No	No	Diminished	1,235	1,180	Constantly lowered.
297	J. P. Leebrick	Mesa	1 N.	5 E.	16	1900	do	61	60	Yes	No	Yes	do	1,246	1,186	Do.
298	I. D. Shumway	do	1 N.	5 E.	16	1897	do	56		Yes	No		do	1,248		Dry.
306	Henry Baker	do	1 N.	5 E.	16		do	56	55	Yes	No	No	do	1,238	1,183	Constantly lowered, very salty.
307	J. T. Lisonbee	do	1 N.	5 E.	16		do	54		Yes	Yes	No	do	1,240		Dry.
308			1 N.	5 E.	16	1897	do	58	56	Yes	No	Yes	do	1,240	1,184	Constantly lowered.
309			1 N.	5 E.	16		do	58	57	Yes	No	No	do	1,243	1,186	Constantly lowered; very salty.
310	J. C. Kimsey	Mesa	1 N.	5 E.	16	1900	do	60	58	Yes	Yes	No	do	1,244	1,186	Constantly lowered; salty.
287	James Nelson	Tempe	1 N.	5 E.	17	1894	do	50	48	Yes	Yes		do	1,230	1,182	Constantly lowered.
386	Wolf Sachs	do	1 N.	5 E.	17	1898	do	19					do	1,195		Dry.
389	J. D. Spooner	do	1 N.	5 E.	18	1898	Driven	18	10	No	Yes	No	Neither	1,188	1,178	
293	E. C. Woodmansee	do	1 N.	5 E.	18	1900	Dug	18	12			Yes	Diminished	1,188	1,176	

294	School	do	1 N.	5 E.	18	1901	do	19	17	Yes	No	No	do	1,188	1,171	
295	Wm. Rohrig	do	1 N.	5 E.	18	1893	do	17	16	Yes	No	No	Neither	1,188	1,172	
296	do	do	1 N.	5 E.	18	1901	do	19	13		No	No	do	1,188	1,175	
118	J. M. Boundtree	Mesa	1 N.	5 E.	18	1902	do	54	53	Yes	Yes	Yes	Diminished	1,242	1,189	
82	W. A. Trent	do	1 N.	5 E.	19		do	50	49	Yes	Yes		do	1,284	1,235	
268	Z. Martin	do	1 N.	5 E.	19	1888	do	39	37		Yes	Yes	do	1,215	1,178	Constantly lowered.
269	do	do	1 N.	5 E.	19	1899	do	31		Yes	Yes	Yes	do	1,215	1,184	
270			1 N.	5 E.	19		do							1,213		
271	—— Gibson	Phoenix	1 N.	5 E.	19	1886	do	37	35	Yes			Diminished	1,211	1,176	Do.
272	J. Johnson	Mesa	1 N.	5 E.	19	1900	do	34	33	Yes			do	1,207	1,174	Do.
273	R. N. Westover	do	1 N.	5 E.	19	1887	do	27	26	Yes			do	1,207	1,181	
275	G. N. Finch	Tempe	1 N.	5 E.	19	1894	do	28	26	Yes	Yes	No	do	1,193	1,167	Do.
288	Fanny Dobbie	Mesa	1 N.	5 E.	19		do	39	37	Yes	Yes		do	1,215	1,178	
289	do	do	1 N.	5 E.	19	1901	do	37		Yes	Yes	No	do	1,215		Dry.
290	L. A. Tewksbury	Tempe	1 N.	5 E.	19	1901	do	38	37	Yes	Yes	Yes	do	1,215	1,178	Constantly lowered.
292	J. W. Stewart	do	1 N.	5 E.	19	1887	do	38	37	Yes	Yes		do	1,211	1,174	Do.
235	Loy Schank	do	1 N.	5 E.	19	1901	do	25	24	Yes	No	No	do	1,196	1,172	
236	do	do	1 N.	5 E.	19	1901	do	26	25	Yes	No	No	do	1,198	1,173	
237	N. W. Brimhall	do	1 N.	5 E.	19		do	27	26	Yes	Yes	Yes	do	1,200	1,174	
238	Nora Brimhall	do	1 N.	5 E.	19	1899	do	30	28	Yes	Yes	Yes	do	1,202	1,174	
213	S. A. Stewart	do	1 N.	5 E.	20	1894	do	44	43	Yes	No	No	do	1,224	1,181	
214	J. S. Toney	Phoenix	1 N.	5 E.	20	1892	do	43	42	Yes		Yes	do	1,222	1,180	
215			1 N.	5 E.	20	1887	do	37		Yes	Yes	Yes	do	1,220		Dry.
217	J. V. Spainhower	Mesa	1 N.	5 E.	20	1896	do	40	38	Yes	Yes		do	1,216	1,178	
259			1 N.	5 E.	20		do	50	48	Yes	No		do	1,228	1,180	Constantly lowered.
261	W. H. Pew	Mesa	1 N.	5 E.	20	1892	do	43		Yes	No	Yes	do	1,226		Dry.
262	D. P. Pew	do	1 N.	5 E.	20	1897	do	46	45	Yes	No	Yes	do	1,225	1,180	
263	M. S. Longmore	do	1 N.	5 E.	20	1902	do	46	45	Yes	No	Yes	Neither	1,224	1,179	Constantly lowered.
264			1 N.	5 E.	20		do	43	41	Yes		Yes	Diminished	1,219	1,178	Do.
265	A. W. Crismon	Mesa	1 N.	5 E.	20	1897	do	41	40	Yes	No	Yes	do	1,218	1,178	Do.
266	Ellen Crismon	do	1 N.	5 E.	20	1899	do	39					do	1,218		Dry.
267	C. T. Wise	do	1 N.	5 E.	20	1892	do	42	40	Yes	No	Yes	do	1,216	1,176	Constantly lowered.
283	Loretti E. Everton	do	1 N.	5 E.	20	1891	do	50		Yes	No	Yes	do	1,233		Dry.
285	Otis Rogers		1 N.	5 E.	20		do	52	50	Yes			do	1,233	1,183	Constantly lowered.

Tabulation of shallow wells—Continued.

MESA TOWNSHIP (T. 1 N., R. 5 E.)—Continued.

Number.	Owner.	Post-office.	Location.			Completed.	How put down.	Depth of well.	Depth to water.	Does water vary at different times of year?	Is water easily lowered?	Did water rise when struck?	Has the volume of water increased or diminished?	Elevation of surface.	Elevation of water.	Remarks.
			Township.	Range.	Section.			*Feet.*	*Feet.*					*Feet.*	*Feet.*	
286	H. N. Pew	Mesa	1 N.	5 E.	20	1896	Dug	41		Yes	No	Yes	Diminished	1,231		Dry.
291	M. L. Gray	Tempe	1 N.	5 E.	20	1890	do	39	37	Yes	No	No	do	1,215	1,178	Constantly lowered.
250	Mrs. Lofgreen	Mesa	1 N.	5 E.	21	1902	do	52	50	Yes	Yes		do	1,239	1,189	Do.
251	J. Pierce	do	1 N.	5 E.	21		do	55	54	Yes	Yes		do	1,237	1,186	Do.
252	Julia Dykes	do	1 N.	5 E.	21	1896	do	52	51	Yes	No		do	1,237	1,186	Do.
253	A. Hunsacker	do	1 N.	5 E.	21	1897	do	54	53	Yes	Yes		do	1,235	1,182	Do.
254	do	do	1 N.	5 E.	21	1897	do	55	54	Yes	Yes		do	1,234	1,180	Do.
255	do	do	1 N.	5 E.	21	1899	do	54	53	Yes	Yes	Yes	do	1,233	1,180	Do.
256	W. N. Standage	do	1 N.	5 E.	21		do	58	56	Yes			do	1,234	1,178	Do.
257	Charles Pew	do	1 N.	5 E.	21	1898	do	50	48	Yes	Yes	Yes	do	1,230	1,182	Do.
258	J. A. Stewart	do	1 N.	5 E.	21	1890	do	52		Yes	Yes	Yes	do	1,230	1,178	
260	Alma School	do	1 N.	5 E.	21	1898	do	47	46	Yes		Yes	do	1,227	1,181	Do.
276	H. Stewart	do	1 N.	5 E.	21	1901	do	55	52		No	Yes	do	1,239	1,187	
277	Jessie Pierce	do	1 N.	5 E.	21	1892	do	53	52	Yes			do	1,240	1,188	Do.
278	J. W. Bond	do	1 N.	5 E.	21	1901	do	56		Yes	Yes	No	do	1,244		Dry.
280	M. F. Davis	do	1 N.	5 E.	21	1895	do	55	53	Yes	No	Yes	do	1,240	1,187	Constantly lowered; salty.
284	J. E. Johnson	do	1 N.	5 E.	21	1894	do	56	55	Yes		Yes	do	1,234	1,179	
186	D. A. Johnson	do	1 N.	5 E.	21	1901	do	55	54	Yes	Yes	Yes	do	1,231	1,177	
187	M. A. Crouse	do	1 N.	5 E.	21		do	53			Yes	Yes	do	1,231		Dry.
188	J. S. Coffin	do	1 N.	5 E.	21	1898	do	54	52	Yes	No	Yes	do	1,230	1,178	
205	M. L. Horrell	do	1 N.	5 E.	21	1899	do	44	43	Yes	No	Yes	do	1,225	1,182	
207	J. R. Standage	do	1 N.	5 E.	21	1897	do	47	46	Yes	Yes		do	1,222	1,181	
246	Wm. Crismon	do	1 N.	5 E.	21		do	50	49	Yes	Yes	Yes	do	1,235	1,186	Constantly lowered

248	A. L. Cuber	do	1 N.	5 E.	21	1882	do	53		Yes	Yes	No	do	1,237		Dry.
249	do	do	1 N.	5 E.	21	1889	do	53	51	Yes	Yes	No	do	1,237	1,186	Constantly lowered.
66	E. N. Grard	do	1 N.	5 E.	22	1897	do	40	39				do	1,233	1,194	
65	H. Dana	do	1 N.	5 E.	22	1901	do	49	47				do	1,233	1,186	
181	P. M. Coleman	do	1 N.	5 E.	22	1892	do	45	43	Yes	No	Yes	do	1,232	1,189	
184	George Woy	do	1 N.	5 E.	22		do	37		Yes	Yes		do	1,232		Dry.
244	D. Le Baron	do	1 N.	5 E.	22	1901	do	49	48	Yes	Yes	Yes	do	1,234	1,186	Constantly lowered.
245	M. Forrester	do	1 N.	5 E.	22	1901	do	50	49	Yes	Yes	Yes	do	1,235	1,186	Do.
247	H. B. Morris	do	1 N.	5 E.	22	1884	do	55	54	Yes	Yes	No	do	1,236	1,182	Do.
104	O. S. Stapley	do	1 N.	5 E.	22	1902	do	50	47	Yes	Yes		do	1,238	1,191	
105	Chas. Sellers	do	1 N.	5 E.	22	1902	do	52	50	Yes	No	Yes	do	1,234	1,184	
107	Mesa Milling Co	do	1 N.	5 E.	22	1899	do	52	48		Yes	Yes	do	1,238	1,190	
108			1 N.	5 E.	22		do	42						1,239		
896	Geo. M. Fryer	Mesa	1 N.	5 E.	22	1898	do	50	46	Yes	No	No	Neither	1,237	1,191	
897	H. H. Gillispie	do	1 N.	5 E.	22	1897	do	52	45	Yes	No	No	do	1,237	1,192	
399	L. V. Guthrie	do	1 N.	5 E.	22	1898	do	44	38	Yes	Yes	No	Diminished	1,233	1,195	
400	P. A. Williams	do	1 N.	5 E.	22	1898	do	47	43	Yes	Yes		do	1,233	1,190	
401	Phillip Coleman	do	1 N.	5 E.	22	1902	do	46	40	Yes	No	No	do	1,233	1,193	
403	Phil Mets	do	1 N.	5 E.	22	1901	do	56	48		No	Yes	do	1,239	1,191	
404	John Nelson	do	1 N.	5 E.	22	1902	do	55	49		Yes	Yes		1,243	1,194	
316	Joe Meyers	do	1 N.	5 E.	22	1898	do	49	48	Yes	Yes	No	Diminished	1,235	1,187	Do.
317	S. L. Elder	do	1 N.	5 E.	22		do	49	48	Yes	Yes	No	do	1,236	1,188	Do.
318	School	do	1 N.	5 E.	22		do	50	49	Yes	Yes	No	do	1,236	1,187	Do.
319	M. B. Ullman		1 N.	5 E.	22		do	50	49	Yes	Yes	No	do	1,237	1,188	Constantly lowered: salty.
230	E. W. Jones	Mesa	1 N.	5 E.	22	1896	do	52	51	Yes	No	No	do	1,237	1,186	Constantly lowered.
321	Kimball Pomeroy	do	1 N.	5 E.	22	1894	do	52	51	Yes	Yes	No	do	1,237	1,186	Do.
322	J. H. Pomeroy	do	1 N.	5 E.	22	1882	do	52	51	Yes	Yes	No	do	1,238	1,186	Do.
323	Jack Frazier	do	1 N.	5 E.	22	1890	do	52	51	Yes	Yes	No	do	1,239	1,188	Do.
324	H. L. Chandler	do	1 N.	5 E.	22	1882	do	52	49	Yes		No	do	1,240	1,191	Do.
325	J. Sirrine	do	1 N.	5 E.	22		do	52	51	Yes	No	No	do	1,240	1,189	Do.
326	Chas. Starr	do	1 N.	5 E.	22	1890	do	53	52	Yes	No	No	do	1,240	1,182	Do.
327	School	do	1 N.	5 E.	22	1890	do	54	52	Yes	No	No	do	1,241	1,189	Do.
328	J. Sirrine	do	1 N.	5 E.	22		do	49	48	Yes	No	No	do	1,241	1,193	Do.
329	G. W. Woy	do	1 N.	5 E.	22		do	56	54	Yes	Yes	No	do	1,242	1,188	Do.

Tabulation of shallow wells—Continued.

MESA TOWNSHIP (T. 1 N., R. 5 E.)—Continued.

Number.	Owner.	Post-office.	Location. Township.	Location. Range.	Location. Section.	Completed.	How put down.	Depth of well.	Depth to water.	Does water vary at different times of year?	Is water easily lowered?	Did water rise when struck?	Has the volume of water increased or diminished?	Elevation of surface.	Elevation of water.	Remarks.
								Feet.	*Feet.*					*Feet.*	*Feet.*	
330	City	Mesa	1 N.	5 E.	22	1901	Dug	59	53		No	No	Diminished	1,240	1,187	
331	Geo. Schornick	do	1 N.	5 E.	22	1901	do	56	53	Yes	No		do	1,239	1,186	
176	P. B. Hughes	do	1 N.	5 E.	22		do	47	46	Yes	No		do	1,233	1,187	
177	L. V. Guthrie	do	1 N.	5 E.	22	1896	do	48	46	No	Yes		do	1,233	1,187	
53	N. Fuller	do	1 N.	5 E.	23	1895	do	43					do	1,233		
50	L. Allen	do	1 N.	5 E.	23		do	42	41				do	1,232	1,190	
89	C. W. Fellows	do	1 N.	5 E.	23	1887	do	45		Yes	Yes		do	1,238		Dry.
90	M. K. McArthur	do	1 N.	5 E.	23		do	40	38	Yes	Yes	No	do	1,236	1,195	
91	W. B. Telford	do	1 N.	5 E.	23		do	50					do	1,235		Dry, salty.
92	do	do	1 N.	5 E.	23		do	31			Yes		do	1,235		Dry, soft.
93	Sarah Whitehead	do	1 N.	5 E.	23	1892	do	50	47	Yes	Yes	Yes	do	1,237	1,190	
94	Hiram Phelps	do	1 N.	5 E.	23	1897	do	46		Yes	Yes	Yes	do	1,237		Dry.
95	H. J. Horne	do	1 N.	5 E.	23	1892	do	45	44	Yes	Yes	Yes	do	1,236	1,192	
96	Hiram Phelps	do	1 N.	5 E.	23	1896	do	50	48	Yes	Yes	Yes	do	1,236	1,188	
97	do	do	1 N.	5 E.	23	1888	do	48		Yes	No	No	do	1,236		Do.
98	M. C. Phelps	do	1 N.	5 E.	23	1892	do	49	47	Yes	No	No	do	1,236	1,189	
99	J. M. Horne	do	1 N.	5 E.	23	1892	do	43	40	Yes	Yes	No	do	1,233	1,193	
100	do	do	1 N.	5 E.	23	1901	do	45	44	Yes	Yes	No	do	1,233	1,189	
101	J. R. Morse	do	1 N.	5 E.	23	1887	do	48	47	Yes	No	No	do	1,238	1,192	
102	J. E. Sirrine	do	1 N.	5 E.	23	1892	do	48	47	Yes	Yes	Yes	do	1,238	1,191	
103	Hannah Johnson	do	1 N.	5 E.	23	1898	do	50	48	Yes	Yes	Yes	do	1,238	1,190	
106	Tempe-Mesa Produce Co.	Tempe	1 N.	5 E.	23	1902	do	49	48			Yes	do	1,238	1,190	
109			1 N.	5 E.	23		do	47						1,239		

111	George Woy	Mesa	1 N.	5 E.	23			45						1,242		
112			1 N.	5 E.	23		Dug	38						1,241		Do.
113			1 N.	5 E.	23		do	55	53	Yes	Yes		Diminished	1,241	1,188	
114			1 N.	5 E.	23		do	60						1,241		
115	Oscar Whitlow	Mesa	1 N.	5 E.	23		do	50	47	Yes	No		Diminished	1,240	1,198	
116	Anna Hall	do	1 N.	5 E.	23		do	60	58	Yes	Yes		do	1,239	1,181	
119	Oscar Whitlow	do	1 N.	5 E.	23		do	31				Yes	do	1,240		Do.
121	O. Daley	do	1 N.	5 E.	23	1900	do	51	50	Yes	Yes	Yes	do	1,244	1,194	Constantly lowered.
83	C. R. Hakes	do	1 N.	5 E.	24	1902	do	52	51	Yes	Yes	No	do	1,246	1,195	
84	W. B. Telford	do	1 N.	5 E.	24	1899	do	55	54	Yes	Yes	Yes	do	1,244	1,190	Water has lowered 34 feet since 1899.
85	L. E. Lamb	do	1 N.	5 E.	24	1900	do	50	49	Yes	Yes	No	do	1,243	1,194	
86	W. B. Telford	do	1 N.	5 E.	24	1895	do	50	49	Yes	Yes	Yes	do	1,242	1,193	
87	W. L. Sirrine	do	1 N.	5 E.	24	1896	do	48						1,242		Dry.
88	E. W. Wilbur	do	1 N.	5 E.	24	1896	do	50	48	No	Yes	Yes	Diminished	1,238	1,190	Constantly lowered.
35	Mary Peterson	do	1 N.	5 E.	24	1893	do	60	58	No	Yes		do	1,238	1,180	
39	H. L. Peterson	do	1 N.	5 E.	24	1898	do	50	47	Yes			do	1,236	1,189	
41	C. Peterson	do	1 N.	5 E.	24	1884	do	52	49	Yes				1,235	1,186	
30	J. A. Allison	do	1 N.	5 E.	25	1896	do	45	44	Yes	No		Diminished	1,235	1,195	
31	do	do	1 N.	5 E.	25	1899	do	52	50	Yes	No		do	1,247	1,195	
32	H. H. Taylor	do	1 N.	5 E.	25	1900	do	50						1,241		
34	P. Weisner	do	1 N.	5 E.	25	1897	do	52	50	Yes			Diminished	1,239	1,189	
37	D. S. Lewis	do	1 N.	5 E.	25	1895	do	52	49	Yes	Yes		do	1,236	1,187	
38	do	do	1 N.	5 E.	25	1890	do	52					do	1,233		
40	H. M. Lewis	do	1 N.	5 E.	25	1897	do	52	50	Yes			do	1,235	1,185	
42	G. W. Lewis	do	1 N.	5 E.	25	1897	do	52	50	Yes			do	1,234	1,184	
46	L. Lewis	do	1 N.	5 E.	25	1897	do	38	37				do	1,226	1,189	
10	N. H. Price	do	1 N.	5 E.	26	1887	do	44	43	Yes	Yes			1,233	1,189	
44	C. H. Allen	do	1 N.	5 E.	26	1892	do	39	37	Yes			Diminished	1,228	1,189	
45	W. J. Clark	do	1 N.	5 E.	26		do	39	38	Yes			do	1,228	1,190	
48	J. L. Coleman	do	1 N.	5 E.	26	1900	do	37	36				do	1,225	1,189	
49	J. S. Allen	do	1 N.	5 E.	26	1896	do	42						1,232		
51	W. Allen	do	1 N.	5 E.	26	1898	do	50						1,231		
52	J. Allen	do	1 N.	5 E.	26	1898	do	50						1,231		
54	W. Brundage	do	1 N.	5 E.	26	1898	do	43	41	Yes			Diminished	1,233	1,192	

Tabulation of shallow wells—Continued.

MESA TOWNSHIP (T. 1 N., R. 5 E.)—Continued.

Number.	Owner.	Post-office.	Location. Township.	Range.	Section.	Completed.	How put down.	Depth of well.	Depth to water.	Does water vary at different times of year?	Is water easily lowered?	Did water rise when struck?	Has the volume of water increased or diminished?	Elevation of surface.	Elevation of water.	Remarks.
								Feet.	*Feet.*					*Feet.*	*Feet.*	
55	N. A. Brundage	Mesa	1 N.	5 E.	26	1898	Dug	42	39				Diminished			
68	S. T. Barnett	do	1 N.	5 E.	26	1896	do	40						1,228		
69	E. Ellsworth	do	1 N.	5 E.	26		do	39	38					1,225	1,187	
72	C. Fuller	do	1 N.	5 E.	26	1900	do	37	35				Diminished	1,220	1,185	
179	M. B. Ullman	do	1 N.	5 E.	27		do	44		Yes	Yes		do	1,232		Dry.
180	Frank Dana	do	1 N.	5 E.	27	1898	do	47	45	Yes	Yes		do	1,232	1,187	Do.
182	Frank Dana	do	1 N.	5 E.	27		do	48		Yes	Yes		do	1,232		
183	A. W. Babbitt	do	1 N.	5 E.	27		do	47	46	Yes	Yes		do	1,232	1,186	
209	H. M. Cooper	do	1 N.	5 E.	27		do	37		Yes	Yes	Yes	do	1,222		Do.
211	do	do	1 N.	5 E.	27		do	41	40				do	1,225	1,185	
212	Joseph D. Crose	do	1 N.	5 E.	27	1899	do	44	42	Yes	Yes	Yes	do	1,228	1,187	
11	H. F. Simmons	do	1 N.	5 E.	27	1900	do	47	44	No	No	Yes	Neither	1,233	1,186	
12	Diffenderfert Ruse	do	1 N.	5 E.	27	1902	do	35	33	Yes	Yes	No	Diminished	1,220	1,187	
13	T. G. Marksbury	do	1 N.	5 E.	27	1886	do	40	38	Yes	Yes	No	do	1,215	1,175	
14	Francisco Arrows	do	1 N.	5 E.	27		do	35						1,219		
15	F. J. Kelley	do	1 N.	5 E.	27	1894	do	34	32	Yes	Yes	No	Diminished	1,217	1,183	
62	F. Marksbury	do	1 N.	5 E.	27	1886	do	41	39				do	1,224	1,185	
63	H. Coleman	do	1 N.	5 E.	27	1893	do	40	39				do	1,224	1,185	
64	J. Drane	do	1 N.	5 E.	27	1893	do	50	48				do	1,233	1,185	
67	A. Millet	do	1 N.	5 E.	27	1891	do	38	37				do	1,228	1,191	
70	R. Longmoor	do	1 N.	5 E.	27		do	40	39				do	1,225	1,186	
75	H. V. Parker	do	1 N	5 E.	27	1900	do	50	49				do	1,220	1,177	
73	L. M. Vance	do	1 N.	5 E.	28	1899	do	33						1,217		
74	J. T. Vance	do	1 N.	5 E.	28	1882	do	36	35				Diminished	1,219	1,184	

140	D. W. Grivel	do	1 N.	5 E.	28	1890	do	32	31	Yes	Yes	Yes	do	1,211	1,180		
189	D. D. Smith	do	1 N.	5 E.	28	1901	do	31					do	1,230		Do.	
190	B. L. Bradford		1 N.	5 E.	28		do	42	41	Yes	Yes	Yes	do	1,223	1,182		
191	P. D. Smith	Mesa	1 N.	5 E.	28	1900	do	37		Yes	Yes	Yes	do	1,223		Do.	
192	Henry Baker	do	1 N.	5 E.	28	1891	do	39	38	Yes	Yes	Yes	do	1,222	1,182		
193	J. T. Vance	do	1 N.	5 E.	28	1892	do	32		Yes	Yes	Yes	do	1,215		Do.	
195	Merritt Clark	do	1 N.	5 E.	28	1890	do	35	34	Yes	Yes		do	1,215	1,181		
199	J. F. Bradberry	do	1 N.	5 E.	28		do	37	36	Yes	Yes		do	1,217	1,181		
203	George Patterson	do	1 N.	5 E.	28	1898	do	41	40	Yes	Yes	Yes	do	1,221	1,181		
206	Church	do	1 N.	5 E.	28	1899	do	45	44	Yes	Yes		do	1,226	1,182		
208	James H. Brooks	do	1 N.	5 E.	28	1896	do	39	38	Yes	Yes		do	1,220	1,182		
185	I. L. Spain	do	1 N.	5 E.	28		do	46	45	Yes	No		do	1,230	1,185		
194	E. Cartwright		1 N.	5 E.	29		do	35	33	Yes	Yes		do	1,214	1,181		
196	C. M. Huffman	Mesa	1 N.	5 E.	29		do	31		Yes	Yes		do	1,215		Do.	
197	do	do	1 N.	5 E.	29		do	34	33	Yes	Yes		do	1,216	1,183		
198	J. W. Baldwin	do	1 N.	5 E.	29	1901	do	34			Yes	Yes	do	1,216		Do.	
200	G. Kleinman	do	1 N.	5 E.	29		do	28		Yes	Yes		do	1,217		Do.	
201	J. P. Huber	do	1 N.	5 E.	29	1893	do	34	33	Yes	No	Yes	do	1,216	1,183		
202	A. P. Kleinman	do	1 N.	5 E.	29	1885	do	38		Yes	No		do	1,220		Do.	
204	Geo. Patterson		1 N.	5 E.	29	1901	do	42	41		Yes	Yes	do	1,222	1,181		
216			1 N.	5 E.	29		do	36		Yes	Yes		do	1,220		Do.	
218	James Biddlecome	Tempe	1 N.	5 E.	29	1901	do	34	33	Yes	No	Yes	do	1,210	1,177	Decreasing.	
222	Arthur Openshaw	do	1 N.	5 E.	29	1898	do	30	29	Yes			do	1,207	1,178		
226	George Way		1 N.	5 E.	29		do	21					do	1,205		Dry.	
242	R. D. Rosenberger	Mesa	1 N.	5 E.	29		do	31	30	Yes	No	No	do	1,208	1,178		
243	Thos. Stapley	do	1 N.	5 E.	29	1886	do	33	31	Yes		Yes	do	1,210	1,179		
133	J. M. Roundtree	do	1 N.	5 E.	29		do	29	28		Yes		do	1,205	1,177		
171	Frank Johnson	Tempe	1 N.	5 E.	30	1896	do	22	20	Yes	No	Yes	do	1,203	1,181		
172	do	do	1 N.	5 E.	30	1895	do	25		Yes	No	Yes	do	1,202			
174	B. F. Johnson	do	1 N.	5 E.	30	1897	do	33	22	Yes	Yes	Yes	do	1,200	1,178		
175	do	do	1 N.	5 E.	30	1885	do	24	23	Yes	Yes	Yes	do	1,200	1,177		
219	E. C. Openshaw	do	1 N.	5 E.	30	1895	do	32	31	Yes	No	No	do	1,207	1,176		
220	School No. 29	do	1 N.	5 E.	30		do	20					do	1,207		Do.	
221	D. C. Brimhall	Mesa	1 N.	5 E.	30	1892	do	30	29	Yes	No	Yes	do	1,207	1,178		
223	S. Openshaw	Tempe	1 N.	5 E.	30	1892	do	30	28	Yes	Yes	Yes	do	1,206	1,178		

Tabulation of shallow wells—Continued.

MESA TOWNSHIP (T. 1 N., R. 5 E.)—Continued.

	Owner.	Post-office.	Location. Township.	Location. Range.	Location. Section.	Completed.	How put down.	Depth of well.	Depth to water.	Does water vary at different times of year?	Is water easily lowered?	Did water rise when struck?	Has the volume of water increased or diminished?	Elevation of surface.	Elevation of water.	Remarks.
								Feet.	*Feet.*					*Feet.*	*Feet.*	
[illegible]	[illegible] Holliday	Mesa	1 N.	5 E.	30		Dug	29	28	Yes	Yes	Yes	Diminished	1,206	1,178	Dry.
[illegible]	Wm. C. Parks	do	1 N.	5 E.	30	1882	do	28	27	Yes	Yes	No	do	1,205	1,180	
[illegible]	Dan Le Baron		1 N.	5 E.	30	1894	do	29	27	Yes	Yes	Yes	do	1,204	1,177	
[illegible]	Peter Lawson	Tempe	1 N.	5 E.	30	1886	do	28	27	Yes	No		do	1,203	1,176	
[illegible]	J. E. Johnson		1 N.	5 E.	30	1890	do	22	20	Yes			do	1,201	1,181	
230	Frankenburg Bros	Tempe	1 N.	5 E.	30	1902	do	25	21	Yes	No		do	1,195	1,174	
233	do	do	1 N.	5 E.	30	1890	do	27	24	Yes	No	Yes	do	1,198	1,174	
234	do	do	1 N.	5 E.	30	1902	do	24	21	Yes	No	Yes	do	1,193	1,172	
239	R. W. Westover	do	1 N.	5 E.	30	1887	do	31	30	Yes	Yes	No	do	1,205	1,175	
240	Luther Spainhower		1 N.	5 E.	30		do	33	31	Yes	Yes	Yes	do	1,207	1,176	
241	J. H. Spainhower	Tempe	1 N.	5 E.	30	1895	do	33	32	Yes	No	No	do	1,209	1,177	
2	Allison Bros	Mesa	1 N.	5 E.	30	1892	do	55	53	Yes	No	No	do	1,244	1,191	
129	F. T. Powers	do	1 N.	5 E.	31	1896	do	26	23	Yes			do	1,199	1,176	
130	do	do	1 N.	5 E.	31	1894	do	23	22	Yes	Yes	Yes	do	1,199	1,177	
131	Forley Johnson	do	1 N.	5 E.	31		do	22	21		Yes	Yes	do	1,198	1,177	
132	do	do	1 N.	5 E.	31		do	21	20	Yes	Yes		do	1,198	1,178	
161	Ed. Weston	Tempe	1 N.	5 E.	31		do	18						1,197		Do.
168	G. S. Johnson	do	1 N.	5 E.	31		do	21	19	Yes	Yes		Diminished	1,192	1,178	
169	do	do	1 N.	5 E.	31		do	21	19	Yes	Yes		do	1,192	1,173	
173	B. F. Johnson	do	1 N.	5 E.	31	1885	do	24	22	Yes	Yes	Yes	do	1,202	1,180	
134	J. R. Blakely	Mesa	1 N.	5 E.	32		do	29	27		Yes	Yes	do	1,205	1,178	
135	J. S. Standage	Tempe	1 N.	5 E.	32	1899	do	26	25	Yes	Yes	Yes	do	1,204	1,179	
136	A. L. Porter	do	1 N.	5 E.	32	1898	do	26	25	Yes	Yes	No	do	1,203	1,178	
137	Arthur Porter	Mesa	1 N.	5 E.	32		do	26			Yes	No	do	1,210		Do.

138	Arthur Millet	do	1 N.	5 E.	32	1888	do	81	30	Yes	Yes	Yes	do	1,210	1,180		
139	Alma Millet	Tempe	1 N.	5 E.	32	1899	do	81	30	Yes	Yes	Yes	do	1,210	1,180		
144	Wm. Dorman	Mesa	1 N.	5 E.	32		do	80	28	Yes	Yes		do	1,209	1,181		
178	P. A. Williams	do	1 N.	5 E.	32	1897	do	51	50	Yes	No	No	do	1,232	1,182		
127	E. W. Wilbur	do	1 N.	5 E.	32	1897	do	28	23	Yes	Yes	Yes	do	1,201	1,176		
141	S. W. J. Bowen	do	1 N.	5 E.	33	1899	do	32	31	Yes	Yes		do	1,211	1,181		
142	Mrs. Ingrams	do	1 N.	5 E.	33		do	80	29	Yes	Yes	Yes	do	1,209	1,180		
143	Herman Priestly	Tempe	1 N.	5 E.	33		do	27						1,209		Do.	
145	do	do	1 N.	5 E.	33		do	28	27	No	Yes		Diminished	1,209	1,182		
146	do	do	1 N.	5 E.	33		do	25						1,209		Do.	
147	John Hibbert	Mesa	1 N.	5 E.	33	1900	do	29	28	Yes			Diminished	1,208	1,180		
148	D. T. Hibbert	do	1 N.	5 E.	33	1890	do	28	26	No	Yes	No	do	1,208	1,182		
149			1 N.	5 E.	33		do	28	27				do	1,209	1,182		
150	Robert Hornbeck	Mesa	1 N.	5 E.	33	1893	do	30	28	Yes	No	Yes	do	1,211	1,183		
151	Leonard Metz	Tempe	1 N.	5 E.	33		do	33	32	Yes	Yes		do	1,213	1,181		
152	do	do	1 N.	5 E.	33		do	33	32	Yes	Yes		do	1,213	1,181		
153	Robert Hornbeck	Mesa	1 N.	5 E.	33	1890	do	33		Yes	Yes	Yes	do	1,214		Do.	
154	do	do	1 N.	5 E.	33	1902	do	83	82	Yes	Yes	Yes	do	1,215	1,183		
155	do	do	1 N.	5 E.	33	1896	do	30					do	1,215		Do.	
156	E. Pomeroy	do	1 N.	5 E.	33	1901	do	32	31	Yes	Yes		do	1,215	1,184		
157	do	do	1 N.	5 E.	33	1900	do	34	32	Yes	Yes	Yes	do	1,215	1,183		
158	do	do	1 N.	5 E.	33	1899	do	34	32	Yes	Yes	Yes	do	1,215	1,183		
159	J. D. Hibbert	do	1 N.	5 E.	33	1902	do	26					do	1,206		Do.	
16	H. E. Dana	do	1 N.	5 E.	33	1888	do	35						1,216		Do.	
17	Theresa Martinez	do	1 N.	5 E.	33	1894	do	35						1,215		Do.	
18	George Scott	do	1 N.	5 E.	33	1896	do	30	27	Yes	Yes	Yes	Diminished	1,210	1,183		
19	do	do	1 N.	5 E.	33	1890	do	35						1,210		Do.	
20	do	do	1 N.	5 E.	33	1890	do	34	33	Yes	Yes	Yes	Diminished				
59	S. Bacca	do	1 N.	5 E.	34		do	30	28				do	1,213	1,185		
2	H. D. Evans	do	1 N.	5 E.	35	1898	do	52	52	Yes	Yes		do	1,221	1,169		
6	R. M. Moore	do	1 N.	5 E.	35	1892	do	44	43	Yes	Yes		do	1,214	1,171		
8	P. B. Hughes	do	1 N.	5 E.	35	1892	do	30						1,220		Do.	

Tabulation of shallow wells—Continued.

TOWNSHIP 1 NORTH, RANGE 6 EAST.

[Records obtained by Robert Muldrow.]

Number.	Owner.	Post-office.	Location. Township.	Location. Range.	Location. Section.	Completed.	How put down.	Depth of well.	Depth to water.	Does water vary at different times of year?	Is water easily lowered?	Did water rise when struck?	Has the volume of water increased or diminished?	Elevation of surface.	Elevation of water.	Remarks.
								Feet.	*Feet.*					*Feet.*	*Feet.*	
1	N. H. Wallace	Mesa	1 N.	6 E.	19	1893	Dug	57	55	Yes	Yes	Yes	Neither	1,231	1,196	
3	Doctor Toney	Phoenix	1 N.	6 E.	30	1893	do	60	57	Yes	Yes	No	Diminished	1,251	1,194	
4	Fred Weeks	Mesa	1 N.	6 E.	30	1900	do	45	44	Yes	Yes	No	do	1,239	1,195	
5	E. W. Wilbur	do	1 N.	6 E.	31	1900	do	50	47	No	No	No	Neither	1,237	1,193	
6	Wm. Eruirn	do	1 N.	6 E.	31	1898	do	50	48	Yes	Yes	No	Diminished	1,243	1,195	
7	Dorman Bros	do	1 N.	6 E.	33	1898	do	100	70	Yes	No	Yes	Neither	1,267	1,197	

TOWNSHIP 2 NORTH, RANGE 5 EAST.

5	F. L. Warner	Phoenix	2 N.	5 E.	8	1903	Drilled	120	100			Yes		1,199	1,099	
1	Indian	Mesa	2 N.	5 E.	21		Dug	61	60					1,263	1,203	
9	Church	Lehi	2 N.	5 E.	29		do	45	43					1,243	1,200	
12	Indian	do	2 N.	5 E.	31		do	37	36					1,231	1,195	
368	do	do	2 N.	5 E.	31		do	31	30					1,221	1,191	
3	do	Mesa	2 N.	5 E.	32		do	33	32					1,226	1,194	
10	do	Lehi	2 N.	5 E.	32		do	36	35					1,230	1,195	
11	do	do	2 N.	5 E.	32		do	39	38					1,233	1,195	
	Indian school	do	2 N.	5 E.	32	1899	do	30	29	Yes	No	No	Diminished	1,220	1,191	Constantly lowered.
	Indian mission	do	2 N.	5 E.	32		do	32	30	Yes	No	No	do	1,220	1,190	
	Indian	do	2 N.	5 E.	32		do	27	26	Yes	No		do	1,218	1,192	
	do	do	2 N.	5 E.	32		do	29	28					1,217	1,189	

367	.....do.....	Lehi.....	2 N.	5 E.	32	.....	Dug	29	28	.....	.....	.....	.....	1,220	1,192	
2	.....do.....	.....do.....	2 N.	5 E.	33	.....	....do...	40	38	.....	.....	.....	.....	1,235	1,197	
4	.....do.....	.....do.....	2 N.	5 E.	33	.....	....do...	40	39	.....	.....	.....	.....	1,238	1,199	
5	.....do.....	.....do.....	2 N.	5 E.	35	.....	....do...	38	37	.....	.....	.....	.....	1,237	1,200	
6	.....do.....	.....do.....	2 N.	5 E.	35	.....	....do...	40	37	.....	.....	.....	.....	1,240	1,203	
	.....do.....	.....do.....	2 N.	5 E.	35	.....	....do...	36	35	Yes...	No....	No....	Diminished ..	1,233	1,198	
7	Day school.....	.....do.....	2 N.	5 E.	36	.....	....do...	44	42	.....	.....	.....	.....	1,242	1,200	
8	Mission	.....do.....	2 N.	5 E.	36	.....	....do...	45	44	.....	.....	.....	.....	1,245	1,201	

TOWNSHIP 1 SOUTH, RANGE 5 EAST.

	M. Barclay.....	Mesa	1 S.	5 E.	1	1890	Dug	36	.....	.....	.....	.....	.....	1,227	.....	Dry.
	Highland school....	.....do.....	1 S.	5 E.	2	1899	....do...	53	52	Yes...	Yes...	No....	Diminished ..	1,221	1,169	
	Wm. Newell	.....do.....	1 S.	5 E.	3	1900	....do...	30	26	Yes...	Yes...	.....	.....do.....	1,212	1,186	
	C. W. Davisson.....	.....do.....	1 S.	5 E.	3	.....	....do...	35	25	.....	.....	.....	.....	1,208	1,183	
	S. Hall	.....do.....	1 S.	5 E.	3	1899	....do...	26	25	.....	.....	.....	Diminished ..	1,211	1,186	
	Michael Fricker	.....do.....	1 S.	5 E.	4	1899	....do...	24	.....	Yes...	Yes...	Yes...	.....do.....	1,206	.....	Do.
	G. A. Dobson.....	.....do.....	1 S.	5 E.	5	1888	....do...	27	25	Yes...	Yes...	.....	.....do.....	1,203	1,178	
	.....do.....	.....do.....	1 S.	5 E.	5	1897	....do...	27	23	Yes...	Yes...	Yes...	Neither.....	1,202	1,179	
	Andrew Housten....	.....do.....	1 S.	5 E.	5	.....	....do...	25	24	Yes...	Yes...	.....	Diminished ..	1,200	1,176	
	Thos. Argue.....	Tempe	1 S.	5 E.	6	1890	....do...	19	.....	.....	.....	.....	.....do.....	1,198	.....	Do.
	.....do.....	.....do.....	1 S.	5 E.	6	1893	....do...	23	22	Yes...	No....	No....	.....do.....	1,197	1,175	
	.....do.....	.....do.....	1 S.	5 E.	6	1890	....do...	21	20	Yes...	No....	No....	.....do.....	1,196	1,176	
	G. S. Johnson	.....do.....	1 S.	5 E.	6	1898	....do...	22	21	Yes...	Yes...	Yes...	.....do.....	1,194	1,173	
	Chas. Pine	Mesa	1 S.	5 E.	12	1893	....do...	45	43	No....	No....	Yes...	Neither.....	1,230	1,187	Very salty.

TEMPE TOWNSHIP (T. 1 N., R. 4 E.).

5	F. L. Warner	Tempe.....	1 N.	4 E.	8	1903	Drilled .	120	100	.....	.....	.....	.....	1,199	1,099	
6	.....	.....	1 N.	4 E.	9	.....	....do...	125	42	.....	.....	.....	.....	1,173	1,131	
2	J. D. Cooper	Tempe.....	1 N.	4 E.	9	1900	Dug	22	18	.....	.....	No....	.....	1,158	1,140	
370	Indian	.....	1 N.	4 E.	12	.....	....do...	15	12	.....	.....	.....	.....	1,185	1,173	
1	T. J. Parry	Tempe.....	1 N.	4 E.	14	1902	....do...	21	17	.....	.....	No....	.....	1,170	1,153	
4	J. H. Commings	.....do.....	1 N.	4 E.	15	1902	....do...	17	16	.....	.....	No....	.....	1,150	1,134	

Tabulation of shallow wells—Continued.

TEMPE TOWNSHIP (T. 1 N., R. 4 E.)—Continued.

Number.	Owner.	Post-office.	Location. Township.	Location. Range.	Location. Section.	Completed.	How put down.	Depth of well.	Depth to water.	Does water vary at different times of year?	Is water easily lowered?	Did water rise when struck?	Has the volume of water increased or diminished?	Elevation of surface.	Elevation of water.	Remarks.
								Feet.	*Feet.*					*Feet.*	*Feet.*	
3	J. D. Cooper	Tempe	1 N.	4 E.	16	1899	Dug	19	18					1,155	1,137	
9	J. Sturgeon	do	1 N.	4 E.	16	1892	do	13	8			No		1,152	1,144	
	Francisco Peralta	do	1 N.	4 E.	16	1894	do	28	25			No		1,153	1,128	
11	Sisto Valdez	do	1 N.	4 E.	16	1901	do	18	16			No		1,150	1,134	
12	G. Mindose	do	1 N.	4 E.	16	1901	do	16	14			No		1,152	1,138	
14			1 N.	4 E.	16	1899	do	16	15			No		1,152	1,137	
15	R. Veltron	Tempe	1 N.	4 E.	16	1892	do	18	16			No		1,152	1,136	
16	—— Gonzalles	do	1 N.	4 E.	16	1898	do	28	18			No		1,155	1,137	
17	Francisco Vajeco	do	1 N.	4 E.	16	1891	do	20	18			No		1,148	1,130	
18	Mrs. Jones	do	1 N.	4 E.	17	1898	do	18	16			No		1,144	1,128	
19	J. T. Priest	do	1 N.	4 E.	20	1889	do	14	12			No		1,144	1,132	
	A. R. Jenkins	do	1 N.	4 E.	20		do		10							
231	Frankenburg Bros	do	1 N.	4 E.	25	1901	do	24	20	Yes	No	Yes	Diminished	1,193	1,173	
232	C. G. Jones	do	1 N.	4 E.	25	1901	do	24	23	Yes	Yes	No	do	1,196	1,173	
	J. W. Johnson	do	1 N.	4 E.	27	1902	Drilled	25								
	Niels Peterson	do	1 N.	4 E.	28		Dug		18							
	do	do	1 N.	4 E.	29	1893	do	25	20			No		1,138	1,118	
	J. P. Jensen	do	1 N.	4 E.	29		do	31	26			No		1,139	1,113	
20	A. H. Brown	do	1 N.	4 E.	31	1899	do	52	49			Yes		1,175	1,126	
	Byron Carr	do	1 N.	4 E.	31		do		32							
	—— Tobin	do	1 N.	4 E.	32				29					1,152	1,123	

21	George W. Nichols	Tempe	1 N.	4 E.	34	1897	Dug	15	8			No		1,178	1,170
165	C. M. Mullen	do	1 N.	4 E.	36	1890	do	22	20	Yes	Yes		Diminished	1,194	1,174
166	do	do	1 N.	4 E.	36	1901	do	22	20	Yes	Yes	Yes	do	1,194	1,174
167			1 N.	4 E.	36		do	13	10					1,194	1,184

TOWNSHIP 2 NORTH, RANGE 4 EAST.

[Records obtained by R. W. Hawley.)

7	F. F. Titus	Tempe	2 N.	4 E.	2	1895	Dug	31	29			No		1,215	1,186
8	H. L. Underhill	Scottsdale	2 N.	4 E.	22	1897	do	75	66			No		1,261	1,195
9	E. M. Toleman	do	2 N.	4 E.	22	1908	do	75	67			Yes		1,262	1,194
10	Chaplin Scott	do	2 N.	4 E.	23		do	67	65			No		1,260	1,195
11			2 N.	4 E.	24		do	69	69			No		1,253	1,184
	W. J. Murphey	Phoenix	2 N.	4 E.	27		do	67	56			No		1,250	1,194
12	do	do	2 N.	4 E.	30	1894	Drilled	98	66			Yes		1,214	1,148
	Thos. Murphey	do	2 N.	4 E.	30	1902	do	325	72			Yes		1,197	1,125
1	Mary Showers	Scottsdale	2 N.	4 E.	36	1901	Dug	40	38			No		1,229	1,191
2	do	do	2 N.	4 E.	36	1900	do	38	37			No		1,227	1,190
3	Wilfred Hayden	Phoenix	2 N.	4 E.	36	1894	do	38	37			No		1,226	1,189
4	Frank Titus		2 N.	4 E.	36	1901	do	60	50			Yes		1,224	1,174
5	Poor ranch	Phoenix	2 N.	4 E.	36	1898	do	40	39			No		1,232	1,192
6			2 N.	4 E.	36		do	26	25			No		1,215	1,190
13	S. W. Ney	Scottsdale	2 N.	4 E.	36	1897	do	38	36			No		1,227	1,191
14	do	do	2 N.	4 E.	36	1908	do	38	36			No		1,227	1,191

Throughout the Mesa region, wherever special inquiry was made, it was found that the surface of the underground water has been continually lowering for years. Wells which were formerly productive throughout the year are now dry for a part or all of the year. With few exceptions the wells have been lowered in order to obtain sufficient water. This lowering of the water has been progressive and wells have been deepened repeatedly. In the vicinity of Tempe the water has lowered about 7 feet. Near Mesa it has lowered much more. According to Code's[a] measurement in 1901, the normal water level at the Murphy-McQueen pumping plant was 22.5 feet below the land surface (see fig. 2, p. 14). On January 19, 1904, this level was found at the same place to be 34 feet below the land surface. At certain places the lowering is reported as 20 feet or even more.

While the underground water supply of the valley has been decreasing for a number of years, there are yearly variations depending more or less directly upon the abundance of surface waters. Certain wells are dry during the dry seasons and contain water during the seasons of more abundant supply. The term "rainy season" is purposely avoided, the seasons of more abundant surface waters being those in which an increased supply enters the valley in streams. The rains in the valley itself are so slight that they have no effect that can be detected in the wells.

THE PHOENIX REGION.

PHOENIX WATER COMPANY'S WELLS.

Previous to 1902 the city of Phoenix was supplied with water from two dug wells, 42 feet deep, which had, when measured, 10 feet of water. During the exceptionally dry season of 1902 the water in these wells failed and three 12-inch double-steel-cased wells were drilled to a depth of 208 feet. An abundant water supply was found at a depth of 55 feet, and thence downward to 208 feet were continuous water-bearing gravels and bowlders. The water from the open wells comes from the upper gravels indicated in the log, and that from the drilled wells comes from the lower gravels. At the time of my visit to the plant water from one open well and one drilled well was supplying the city at the rate of about 1,750 gallons per minute. It is said that one of the drilled wells alone has yielded water at this rate.

Log of well of Phoenix Water Company, near Phoenix.

	Feet.
Soil	13
Gravel and bowlders, water bearing	36
Clay and cement	7
Gravel and bowlders, water bearing	153

[a] Code, W. H., Report of irrigation investigations for 1901, No. 1: U. S. Dept. Agric., Bull. 119, 1902, p. 67.

Unfortunately there was no opportunity of obtaining satisfactory pumping tests at this plant. The amount named, 1,750 gallons per minute, is estimated from the time it takes to fill the standpipe.

As in the case of the well at the asylum and other wells to be described later there is no marked difference between the upper and lower water bodies, although the two are separated by 7 feet of clay and cement. No. 3, in the table below, is an analysis of water from the upper water body and No. 4 from the lower body. The samples were taken directly from the wells at a time when the pumps were in operation.

Much interest is taken by the water users of the valley in the supposed improvement in the quality of the water as the wells are used. Reference has been made to such an improvement in case of the Chandler wells and others. Four analyses of the Phoenix city supply have been made, as indicated below. The three analyses representing the shallow wells extend over a period of about 5.5 years. Since this water supplies the city the draft on the wells is constant, and if use will materially improve the quality of wells, this water should show an improvement. On the contrary, the latest analyses indicate a marked increase in the quantity of soluble salts.

Analyses of water from the Phoenix Water Company's wells.

	1. Dug well, Sept. 18, 1898.	2. Dug well, May 9, 1902.	3. Dug well, May 14, 1903.	4. Drilled well, May 14, 1903.
Quantitative (parts in 100,000):				
Total solids soluble at 110° C	116.8	102.4	136.00	132.00
Chlorine in terms of NaCl (common salt)	72.5	54.6	80.80	77.60
Hardness in terms of $CaSO_4$ (sulphate of lime)	Strong.	8.98	6.53	5.44
Alkalinity in terms of Na_2CO_3 (black alkali)	.....	.....	.00	.00
Nitrogen in the form of nitrates	.10	.16	.25	.25
Nitrogen in the form of nitrites	.0007	.0045	.02	Very faint.
Qualitative:				
Sulphates	.....	Very strong.	Pronounced.	Pronounced.
Magnesia	.....	Very strong.	Pronounced.	Pronounced.
Lime	.....	Very strong.	Strong.	Strong.
Bicarbonates	.....	.....	Strong.	Very strong.

PHOENIX LIGHT AND FUEL COMPANY'S WELL.

This company has a single 12-inch double-steel-cased well at the power house in Phoenix. The well is 194 feet deep, with water at a depth of 31 feet. Below a depth of 46 feet, 16 feet of clay and cement occur. Otherwise, throughout the entire depth of the water-bearing portion, the material is coarse and wholly unconsolidated.

Log of Phoenix Light and Fuel Company's well.

	Feet.
Soil	15
Gravel, water in the lower part	31
Cement	2
Clay	11
Cement	3
Quicksand	3
Sand, gravel, and bowlders, water bearing	129

A shaft has been sunk to near water level and cemented to exclude any moisture from without. At the bottom of this shaft is placed the centrifugal pump and 50-horsepower electric motor. The water is used for condensing steam in the power house, after which it is used for irrigation.

A careful pumping test was made at this plant under the direction of Mr. D. W. Beldon, the engineer in charge, with results given below. It will be noted that in this case a single 12-inch well is yielding 1,995 gallons of water per minute continuously, with a local depression of the water table of little more than 16 feet.

Report of test on electrically driven centrifugal pump for irrigation.[a]

[Test made January 10, 1904, by D. W. Beldon, electrical engineer.]

Motor (3 phase; 350 volt; 60 cycle) speed	r. p. m.	720
Pump (direct-connected centrifugal; 10-inch suction; 8-inch discharge) r. p. m		720
Height; pump center above water (still)	feet	5¼
Vacuum; pump running	inches	20
Water lowered by pump running (22 feet − 5⅛ feet)	feet	16⅞
Head above vacuum gauge	do	19
Total head (less friction and velocity of discharge)	do	41
Water pumped per minute	cubic feet	266
Total power absorbed by motor	kilowatts	38.6
Kilowatt hours required per acre-foot		105
Cost of power per acre-foot (2 cents per kilowatt hour)		$2.10
Cost of power per acre-foot (per foot of lift)		$0.0512

PERKINS WELL (SEC. 23, T. 2 N., R. 3 E.).

Mr. C. W. Perkins has a 10-inch drilled well 155 feet deep. The water surface is 83 feet below the surface of the ground. The well is

[a] This report did not reach the writer in time to be included in the computations of cost described in the following chapters. The cost does not differ materially from that of other well-equipped pumping plants.

situated at Mr. Perkins's olive-oil factory, and the water is used for irrigating his olive and orange orchards during dry times when ditch water can not be obtained. The distance through which the water must be raised (a minimum of 83 feet) prohibits its economic use except as a last resort. Before the well was put down the lack of water in the irrigation canals at critical times caused serious damage to the fruit and even the death of a large number of trees. Costly as it is to pump from such a depth, water at a critical time is worth much more than it costs in saving valuable crops that might otherwise be injured or wholly destroyed. The well yields about 200 gallons per minute. The water is lifted by means of a deep-well pump, operated by a gasoline engine.

Analysis of water from C. W. Perkins's well.

Quantitative (parts in 100,000):	
Total solids soluble at 110° C	83.60
Chlorine in terms of NaCl (common salt)	30.80
Hardness in terms of $CaSO_4$	8.30
Alkalinity in terms of Na_2CO_3	.00
Nitrogen in the form of nitrates	.53
Nitrogen in the form of nitrites	.871
Qualitative:	
Sulphates	Very strong.
Magnesia	Strong.
Lime	Strong.

PHOENIX MACHINE AND COLD STORAGE COMPANY'S WELL.

The well is located at the company's factory in Phoenix, and was put down in December, 1903. It is a 12-inch double-steel-cased well 125 feet deep. Only 5 feet of fine material was encountered at the surface, all below this being entirely loose sand, gravel, and bowlders. Water is raised by means of a deep-well cylinder pump, but since no great supply is required the capacity of the well is not known.

Log of Phoenix Machine and Cold Storage Company's well.

	Feet.
Soil	5
Sand and bowlders slightly cemented	12
Sand, gravel, and bowlders, water bearing	118

BARTLETT-HEARD LAND AND CATTLE COMPANY'S WELLS (SEC. 30, T. 1 N., R. 4 E.).

An extensive pumping plant has been planned for this company for the purpose of obtaining an auxiliary water supply for a large tract of land lying south of Phoenix. A battery of six 15-inch double-steel-cased wells has been established, but the machinery is not installed at this writing. A depth of 28 feet of soil was penetrated, and water-bearing bowlders were encountered to a depth of 90 feet. The bowl-

ders are underlain by granitic wash, 10 feet of which was penetrated. The water-bearing material is coarse and unconsolidated. Numerous quartzite bowlders up to 1 foot in diameter were taken from the well in drilling. The water is under no pressure and its surface does not even reach the top of the gravel bed, resting at a depth of 32.5 feet. On account of the limited thickness of the gravel bed drilling was suspended after the completion of the second well and a preliminary pumping test was made under the direction of Mr. Fuller, the engineer in charge, in order to determine whether the available quantity of water would justify the establishment of the plant at this place.

Log of Bartlett-Heard Land and Cattle Company's well No. 3.

	Feet.
Sand and soil	28
Gravel and bowlders, water bearing	62
Granite wash	10

The perforated areas of the wells differed in the proportion of 3 to 5, and the one having the smaller perforation area was tested, on the assumption that if it proved satisfactory there could be no question regarding those having better perforations. A shaft was dug to water level and a small centrifugal pump placed at the bottom and belted to an 18-horsepower traction engine at the surface. The pump was operated 2.5 hours and readings were taken every ten minutes. It discharged an average of 78.8 miner's inches of water (886 gallons per minute) and lowered the water in the well 19 feet and 8 inches (fig. 10). The water in the second well, 15 feet from the one tested, was lowered only 2 feet. Within thirty seconds after the pump stopped the water rose to the normal level. A lighter demand makes correspondingly less depression of the water table and therefore a lower lift. The same effect is also obtained by better perforation of the casing. The present lift of 53 feet can probably be materially lessened and the desired quantity of water can be still obtained by sinking a number of properly perforated wells.

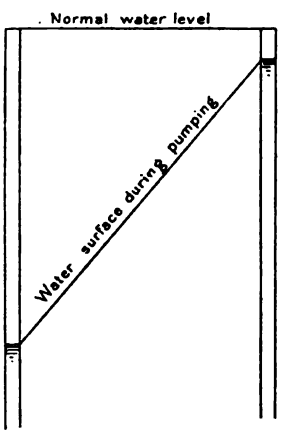


FIG. 10.—Depression of water table during pumping test of the Bartlett-Heard well.

Analysis of water from the Bartlett-Heard Land and Cattle Company's well.

[Sample taken during the pumping test, February 4, 1904.]

Quantitative (parts in 100,000):	
Total solids soluble at 110° C	194.0
Chlorine in terms of NaCl (common salt)	126.0
Hardness in terms of $CaSO_4$ (sulphate of lime)	35.44
Alkalinity in terms of Na_2CO_3 (black alkali)	None.
Nitrogen	None.

Qualitative:

Sulphates	Strong.
Magnesia	Strong.
Lime	Strong.
Bicarbonates	Very strong.

WELL AT THE TERRITORIAL ASYLUM FOR THE INSANE (SEC. 2, T. 1 N., R. 3 E.).

The asylum is situated about 3 miles east of Phoenix on the Phoenix-Tempe road. A shaft 12 by 14 feet and 22.5 feet deep is tightly bricked and cemented to shut out any surface water which might seep in. From the bottom of this shaft a 12-inch well was sunk 87.5 feet, or 110 feet below the surface of the ground. At a depth of 57 feet the water-bearing gravel was struck, but the supply of water is not as great as in other wells entering what is presumably the same gravel bed. This may possibly be due to imperfections of construction; only the lower 24 feet of the pipe are perforated, and these perforations were made before the casing was forced into the well. After the pipe was in place the well was "shot." This increased the available supply to a quantity sufficient for the present needs of the asylum, but the yield is not yet as great as might reasonably be expected.

Log of asylum well, near Phoenix.

	Feet.
Soil	12
Gravel, water bearing	16
Clay and cement	9
Gravel and bowlders, water bearing	53

A steam pump is located at the bottom of the shaft and a suction pipe 24 feet long extends into the well. The engine is usually run at a rate which lifts 95 gallons per minute, and depresses the water surface 5 feet. This has been found to be practically the capacity of the well.

There are two water-bearing horizons in this well separated by 9 feet of clay and cement. Since the casing is perforated only near the bottom, the upper water is shut off, and analysis 1 of the following table is from water of the lower gravels. Analysis 2 is from water of a well 42 feet deep and therefore from the upper body. The great similarity of the analyses indicates that the two water bodies are probably connected.

Analyses of water from the asylum well, near Phoenix.

	No. 1.	No. 2.
Quantitative (parts in 100,000):		
Total solids soluble at 110° C.	126.40	120.40
Chlorine in terms of NaCl (common salt)	78.80	79.20
Hardness in terms of $CaSO_4$ (sulphate of lime)	13.60	8.20
Alkalinity in terms of Na_2CO_3 (black alkali)	None.	None.
Nitrogen in the form of nitrates	Faint.	Faint.
Nitrogen in the form of nitrites	Faint.	Faint.
Qualitative:		
Sulphates	Very strong.	Very strong.
Magnesia	Strong.	Very strong.
Lime	Strong.	Very strong.
Bicarbonates		

PHOENIX INDIAN SCHOOL WELLS (SEC. 20, T. 1 N., R. 3 E.).

There are three deep wells at the Indian School, one at the power house and two, designed for irrigation, some distance from the school buildings. The well at the power house is 193 feet deep and 6 inches in diameter. The water is used to supply the school buildings and lawns and is pumped at the rate of about 60 gallons per minute.

The first irrigation well is dug to a depth of 56 feet. From the bottom of this pit two 6-inch holes have been drilled, the first 145 feet and the second 338 feet in depth. The water stands 36 feet beneath the surface. It was the original plan to cut the well casing at the bottom of the open part and allow the water to flow from the drilled wells into the open well, from which it was to be lifted by a bucket pump.

Log of Phoenix Indian School irrigation well No. 1.

	Feet.
Soil and cement	40
Sand, cemented in places	40
Hard, white cement	15
Quicksand	6
Sandy clay	66
Sand, water bearing	26
Alternating beds of sand, clay, and cement (no definite record)	62
Cement	20
Cemented sand	24
Granite wash, water bearing	12
Sand and gravel	12
Cemented sand	8
Sand and gravel, water bearing	9
Gravel and bowlders, water bearing	3

The material passed through gave promise of comparatively little water. A gravel bed was encountered at the depth of 335 feet, but

since the casing was not extended to the bottom no headway could be made in the loose gravels, and the drilling was abandoned for a time. The gravel bed at the bottom is promising, but its thickness and character are unknown. At a preliminary pumping test only 10 inches of water was obtained.

The well is supplied temporarily with a bucket pump operated by an electric motor. When running at ordinary speed, the pump discharges about 200 gallons of water per minute and soon drains the open well. A discharge of about 100 gallons per minute maintains the water level at 52 feet, a depression of 16 feet, thus indicating the practical capacity of the well. During the time that the water surface was held at a depth of 52 feet the water flowed from the top of the drilled wells into the open part, but without any great force. The rate of discharge is slow, and the outlook for an underground supply is not encouraging.

A good example of the depression of the water table is found at this place. In the year 1895 a well at the Indian School encountered water at a depth of 16 feet. The same well, deepened as the water surface lowered, in January, 1904, contained water at a depth of 38 feet—a depression of 22 feet in about eight years.

Log of Phoenix Indian School irrigation well No. 2.

	Feet.
Soil, sand, and cement	85
Sand, water bearing	14
Cemented sand	40
Putty clay	30
Sand	10
Putty clay	16
Sand and gravel	30
Red sandstone	3

A third well has been put down on the Indian School farm 1 mile east of the school. It is a 6-inch drilled well 228 feet deep. An incident occurred in drilling this well which has an important bearing on the quantity of water to be expected in this vicinity. Water was found at a depth of about 51 feet and rose 15 feet, keeping the well filled until a sand stratum was encountered at a depth of about 170 feet. The water from above entered this sand and lowered the surface of the water in the well to about 100 feet—a depression of about 64 feet. This level was maintained, the sand absorbing the entire flow from the higher water horizons until the leakage was stopped by clay pounded into the loose sand by the action of the drill.

This well is slightly more promising than No. 1, but no test has been made. The red sandstone at the bottom is probably the breccia exposed at the surface farther to the east and north.

Analyses of water from wells at the Phoenix Indian School.

	No. 1 (45 feet).	No. 2 (145 feet).	No. 3 (15 feet).	No. 4 (60 feet).
Quantitative (parts in 100,000):				
Total solids soluble at 110° C	245.20	250.00	222.00	362.30
Chlorine in terms of NaCl (common salt)	160.80	145.00	141.00	258.00
Hardness in terms of $CaSO_4$ (sulphate of lime)	21.80	65.80	None.	Strong.
Alkalinity in terms of Na_2CO_3 (black alkali)	None.	None.	33.36	None.
Nitrogen in the form of nitrates	.40	.25	Faint.	.30
Nitrogen in the form of nitrites	Faint traces.	.00	.0008	.0028
Qualitative:				
Sulphates			Very strong.	Very strong.
Magnesia			Very strong.	Very strong.
Lime			Very strong.	Very strong.
Bicarbonates			Strong.	Strong.

G. W. SMITH'S WELL (SEC. 10, T. 1 N., R. 3 E.).

This well is dug 20 by 40 feet, 38 feet deep, and has 8 feet of water. The lower half of the well is in coarse sand, gravel, and bowlders, and required careful timbering to keep the sides from caving in. It was the material from this well which was used in the experiment described later under the caption of "practical porosity." The water is raised by means of a 12-horsepower gasoline engine and 6-inch horizontal centrifugal pump, at the rate of about 50 inches (564 gallons) per minute. The water is used for irrigation.

THE KUNZ WELL (SEC. 18, T. 1 N., R. 3 E.).

The well of Dr. R. E. Kuntze and L. Kunz & Sons is 6 by 6 feet, 24 feet deep, and has 6 feet of water. It was begun in 1899 and has since been lowered, but the water is now gradually rising. It is used for irrigating a botanical garden containing various kinds of shrubs, trees, and flowers. Since 1899 the garden has been irrigated with no other water.

The pump is a novel invention of one of the owners of the place and has comparatively high efficiency. The essential part of the mechanism is a light walking beam about 12 feet long hinged at the center.

with its extremities traveling over a sinuous track. Near the center of the walking beam is placed a system of levers which operate two suction pumps. A mule is hitched to the pump in the ordinary manner, and when properly blindfolded works without a driver. As the machine is turned the walking beam is made to oscillate in a vertical plane by means of the sinuous track, and thus works the pumps.

The comparative ease with which water is raised by this machine and the claim that horsepower is cheaper than gasoline or steam led to a careful measurement of the amount pumped and the computation of cost as given below. The value of the mules employed is probably exaggerated; more valuable animals would do correspondingly more work. The pasturage is counted at $1.50 per month for each animal and feed at $1.30 per month.

Cost of pumping by mule power at the Kunz gard.

Cost of well and pump	$200.00
Two mules at $25	$50.00
Interest on investment at 7 per cent per annum for 3.6 days	$0.17
Depreciation at 10 per cent per annum for 3.6 days	$0.24
Average amount pumped per minute, in gallons	62
Days required to pump 1 acre-foot	3.6
Pasture and feed for 2 mules at 19 cents per day for 3.6 days	$0.68
Oil and incidentals (estimated)	$0.05
Total cost per acre-foot	$1.14
Lift, in feet	18
Average cost per foot in raising 1 acre-foot of water	$0.063

Analysis of water from the Kunz well.

Quantitative (parts in 100,000):	
Total solids soluble at 110° C	223.00
Chlorine in terms of NaCl (common salt)	146.80
Hardness in terms of $CaSO_4$ (sulphate of lime)	53.70
Alkalinity in terms of Na_2CO_3 (black alkali)	None.
Qualitative:	
Sulphates	Very strong.
Magnesia	Strong.
Lime	Very strong.
Bicarbonates	Very strong.

EAST LAKE PARK WELL.

This well supplies water for a natatorium, for an artificial lake, and for general park use. It is 7 by 10 feet, 42 feet deep, and has 9 feet of water. Water is raised by a bucket pump operated by an electric motor. At the time of my visit to this plant the pump was discharging water at the rate of 210 gallons per minute, and this seemed to be the maximum capacity of the well.

WAGNER WELL (SEC. 16, T. 1 N., R. 3 E.).

Mr. Frank Wagner has a dug well 7 by 7 feet and 35 feet deep, from which he pumps water for the irrigation of his gardens and nursery. The well is provided with bucket pump and horsepower, by means of which water is raised at the rate of about 12 inches (135 gallons) per minute.

WETZLER WELL (SEC. 11, T. 1 N., R. 3 E.).

Lewis Wetzler's well is dug 8 by 8 feet and 40 feet deep, and contains 15 feet of water. Water is raised by means of a bucket pump and a 5-horsepower gasoline engine at the rate of about 35 inches (396 gallons) per minute. This water has been used since 1900 in raising garden produce.

Analysis of water from Lewis Wetzler's well, near Phoenix.

Quantitative (parts in 100,000):	
Total solids soluble at 110° C	144.00
Chlorine in terms of NaCl (common salt)	86.00
Hardness in terms of $CaSO_4$ (sulphate of lime)	23.90
Alkalinity in terms of Na_2CO_3 (black alkali)	None.
Qualitative:	
Sulphates	Pronounced.
Magnesia	Very faint.
Lime	Strong.

M'CALLUM WELL (SEC. 24, T. 1 N., R. 2 E.).

N. P. McCallum's well is situated on the southern bank of Salt River about 4 miles southwest of Phoenix. It is a dug well 9 feet in diameter and 31 feet deep, walled with brick for the lower 15 feet. Spaces are left in the brick wall to allow the seepage water to enter from the side. The well is dug in the sands and gravels of the river deposit a few feet from the southernmost channel of the river. This channel serves at present as a seepage ditch carrying a small amount of water. This water is led by a subterranean passage into the well and adds materially to the amount available for pumping.

The water stands normally 14 feet below the surface. An 8-inch Byron Jackson centrifugal pump is placed a few feet above the normal water level and operated by a 40-horsepower traction engine. The amount of water pumped at present is estimated at 1,100 gallons per minute. With this yield the water in the well is lowered 12.5 feet, and remains stationary. A heavier demand drains the well.

Mr. McCallum's ditch is arranged to take flood water from the river whenever such water is available. The pump water is discharged into the same ditch. A subway from the pump to the ditch is cut 9.5 feet below the surface. The water is therefore lifted only 17 feet when the pump is discharging 1,100 gallons per minute.

A 12-inch double-steel-cased drilled well has recently been put down at this point. It is 124 feet deep and penetrates nothing but unconsolidated sand, gravels, and bowlders. A preliminary test gave 175 inches of water (1,970 gallons per minute).

Log of N. P. McCallum's drilled well, near Phoenix.

	Feet.
River sand	10
Gravel and bowlders, water bearing	114

COLLINS WELL (SEC. 15, T. 1 N., R. 2 E.).

Mr. George U. Collins's well is situated about 3 miles southwest of Phoenix. It is a large seepage well 100 feet long by 60 feet wide and 29 feet deep. The material encountered for the upper 10 feet is sandy soil and for the remaining 19 feet river gravel and bowlders. When the pump is not running the water rises to within 19 feet of the surface of the ground. The water is raised by a 60-horsepower steam engine and a horizontal centrifugal pump which furnishes a continuous supply day and night of 190 to 200 inches, or about 2,200 gallons per minute. When pumped at this rate the water in the well is lowered 6 feet, at which level the inflow equals the amount pumped and the surface remains stationary. When a greater amount is pumped, the surface of the water is proportionately lowered. (See Pl. V, *B*.)

The bed of gravel and bowlders in which the well is sunk has evidently a somewhat free connection with the underflow of the river. At the time of my first visit to the well the pump had not been in operation for several days, and the water was standing at normal level. There was a distinct current in the well caused obviously by the passage of the underflow through it. The inflowing current was stronger at one end than at the other, resulting in a slow eddying movement of the water bearing the floating material in an endless journey about the well.

Mr. Collins was kind enough to give some figures and facts gleaned from his long experience which may be of benefit to those thinking of constructing similar plants. The cost of digging and casing the well was $11,900—probably more than a similar well would cost in some places. The looseness of the gravel and bowlders and the abundance of water in them make excavation a costly process; it should be noted, however, that easier digging due to more consolidated gravels is likely to be accompanied by a smaller water supply.

The plant has been in operation for three years, and land which is irrigated from it is producing as good, and in some cases better, crops than the neighboring land irrigated with ditch water. This may be due to the fact that pumped water can be applied when needed while ditch water must be used at stated times. While the water is derived wholly from the underflow, the quantity and kinds of salts contained

in it are not such as to warrant the doubt of its utility that exists in the minds of many people in the valley. It will be noted from the following analysis that the total of contained salts is comparatively low and that the greatly feared black alkali is absent.

Analysis of water from George U. Collins's well, near Phoenix

Quantitative parts in 100,000:	
Total solids soluble at 110° C	150.00
Chlorine in terms of NaCl (common salt)	94.80
Hardness in terms of $CaSO_4$ (sulphate of lime)	17.40
Alkalinity in terms of Na_2CO_3 (black alkali)	None.
Qualitative:	
Sulphates	Strong.
Magnesia	Strong.
Lime	Strong.
Bicarbonates	Strong.

Measurements were made at the Collins well for the purpose of computing the cost of pumping. The water was measured in a temporary weir and the quantity given (190 inches) is approximately correct. Leakage at several points occasioned some loss.

Cost of pumping water at the Collins pumping plant.

Cost of well	$11,900.00
Cost of pump and engine	$3,100.00
Interest on $15,000 at 7 per cent per annum for 2.6 hours	$0.31
Depreciation at 10 per cent per annum for 2.6 hours	$0.44
Average discharge of water in inches	190
Average discharge of water in second-feet	4.75
Hours to pump 1 acre-foot	2.6
1.5 cords of wood lasts 14 hours (average).	
Cost of wood for 2.6 hours, at $1.50 per cord [a]	$0.48
Oil and incidentals (estimated)	$0.05
Engineer, 2.6 hours, at 25 cents per hour	$0.65
Total cost per acre-foot	$1.93
Total lift in feet	22
Average cost per foot of raising 1 acre-foot	$0.07
With wood, reckoned at $4 per cord: [a]	
Total cost per acre-foot	$2.75
Average cost per foot of raising 1 acre-foot [a]	$0.124

NELSON & McILWAINE WELLS (SEC. 15, T. 1 N., R. 2 E.).

These wells are located near the river, about 3 miles southwest of Phoenix. There are two, 7 feet in diameter and 26 feet deep, dug side by side and communicating. The water is raised by a 20-horse-

[a] Wood is reckoned at $1.50 per cord; this is its cost of cutting and hauling and not its purchase price. Since fuel is the principal item of expense the purchase price of wood should be counted in order to compare the cost of water at this point with the cost where fuel is purchased in the open market. Four dollars per cord may be considered an average price for the wood used at this plant. This would raise the cost of fuel for 1 acre-foot of water to $1.28 instead of 48 cents and make the total cost per acre-foot $2.75 and the average cost per foot of raising 1 acre-foot of water 12.4 cents in place of 7 cents.

power "Model" gasoline engine and an 8-inch centrifugal pump at the rate of 900 gallons per minute. The water surface is 16 feet below the surface of the ground at present, but varies with the water in the river. At the time of my visit the water was abundant in the river, and the water in the wells was lowered only 5 feet by pumping. During dry seasons, when there is little water in the river, the water stands at a lower level in the wells and the pump lowers it more easily, and even drains the wells. The quantity of water is also affected by the irrigation of lands in the vicinity, being noticeably more abundant in the wells during times of extensive or continued irrigation. The supply drawn from by this pumping plant is therefore due to seepage, partly from the underflow of the river and partly from the return waters from irrigated lands.

The well water is found to be very useful in the cultivation of crops which grow on or near the ground, such as strawberries, melons, etc. Ditch water is used at certain times for all crops on the ranch, but the well water is used at times when muddy ditch water would be detrimental to the crops. The river water, especially in times of flood, contains large quantities of silt, and during dry times the supply may fail altogether. The well water, being free from silt, is used, not only in times of drought, when river water is scarce, but also in flood times, when the use of silty water would injure the crops.

This pumping plant offered favorable opportunity for computing the cost of raising water by means of the gasoline and centrifugal pump. The measurements of the water were made by means of a temporary weir constructed for the purpose, and the quantity of gasoline used is based on an average of many runs. The pump is used ordinarily not more than one hour at a time, but some runs of several hours have been made. Long runs took proportionately less gasoline. Since nearly all the runs in the present case were short ones the computed cost of an acre-foot is greater than it would be if the plant were in continuous operation. The quantity of gasoline consumed in the longest runs, while not accurately measured, was enough less to warrant the assumption that this plant could raise water 21 feet at a cost not exceeding $2.50 per acre-foot.

Cost of pumping water at Nelson & McIlwaine's pumping plant, near Phoenix.

Cost of well (estimated)	$1,000.00
Cost of engine and pump	$1,200.00
Interest on investment at 7 per cent per annum for 6 hours	$0.11
Depreciation at 10 per cent per annum for 6 hours	$0.16
Average amount of water in gallons per minute	900
Hours to pump 1 acre-foot	6
Average amount of gasoline per minute ....gallons	1.5
Gallons of gasoline to pump 1 acre-foot	9
9 gallons of gasoline at 28 cents	$2.52
Oil, repairs, etc. (estimated)	$0.05

Total cost per acre-foot	$2.88
Lift in feet	21
Average cost per foot in lifting 1 acre-foot	$0.137

PERRY WELL (SEC. 22, T. 1 N., R. 2 E.).

Mr. Wm. H. Perry's well is located north of the river, not far from the Collins well. It is 12 by 16 feet at the top and at present writing is about 20 feet deep; it is not yet complete. Water occurs at a depth of 14 feet and will be raised by centrifugal pump and steam engine having a capacity of about 2,000 gallons per minute.

The well is about three-fourths of a mile from the river, and the elevation of the water in it is influenced by the flow in the river. Three weeks before visiting the well the river was in flood. After the flood had passed, the water in the well gradually rose until at the time of visit the surface was 3 feet higher than it had been three weeks before.

BRADSHAW WELL (SEC. 15, T. 1 N., R. 2 E.).

The well of J. R. and W. W. Bradshaw is 8 by 16 feet and 27 feet deep, and has 8 feet of water. The water is raised by a 6-inch centrifugal pump and 12-horsepower gasoline engine; when in use a stream of 60 inches (675 gallons per minute) is obtained. The plant has not been in use during the present season, 1903, owing to the fact that a satisfactory supply of ditch water was obtained cheaper than water could be pumped.

BROWN WELL (SEC. 13, T. 1 N, R. 2 E.).

J. L. Brown has a dug well, 7 feet in diameter and 19 feet deep, with 6 feet of water. The water, which, until recently, was used for irrigation, was raised by a bucket pump, the power being supplied by 8 horses hitched into a circular arrangement similar to a merry-go-round. A stream of 25 inches (281 gallons per minute) was obtained when the pump was operated. It has not been in use for about two years.

HARRIS WELL (SEC. 6, T. 1 N., R. 2 E.).

J. J. Harris has a 4-inch drilled well 103 feet deep. Water was encountered at a depth of 32 feet, but it contained common salt and alkali in quantities sufficient to render it unfit for use. Again, at a depth of 47 feet, water was encountered so strongly impregnated with salts that it is described as brine. At a depth of 98 feet a gravel bed was encountered, yielding a supply of good water.

Log of J. J. Harris's well.

	Feet.
Soil and clay	32
Sand and gravel, salt water	2
Clay and cement	13
Sand and gravel, brine	3
Clay and gravel	38
Hard cement	10
Gravel and bowlders, water bearing	3

The water from the gravel bed at the bottom of the well rises to within 30 feet of the surface of the ground, 2 feet above the surface of the upper water horizon. The upper saline waters are cased off and the water used is from the lower gravel stratum. The analysis of this water is as follows:

Analysis of water from J. J. Harris's well.

Quantitative (parts in 100,000):	
Total solids soluble at 110° C	268.00
Chlorine in terms of NaCl (common salt)	185.60
Hardness in terms of $CaSO_4$ (sulphate of lime)	34.80
Alkalinity in terms of Na_2CO_3 (black alkali)	None.
Nitrogen in the form of nitrates	2.00
Nitrogen in the form of nitrites	Very faint.
Qualitative:	
Sulphates	Strong.
Magnesia	Strong.
Lime	Very strong.
Bicarbonates	Pronounced.

KELLNER WELL (SEC. 6, T. 1 N., R. 1 E.).

Mr. E. F. Kellner's well, which is situated 12 miles west of Phoenix on the Yuma road, is a 7-inch well 554 feet deep. A light flow of water was obtained at 322 feet, which rose to within 18 feet of the surface. The purpose in sinking the well was to obtain if possible a supply of flowing or artesian water. Owing to accidents in the work the well was never completed and has never been used.

In January, 1904, in taking the temperature of the well it was found to be only 324 feet deep, the lower 230 feet having filled with sand. Water was found at a depth beneath the surface of 32 feet, a lowering of 14 feet since the well was drilled. The temperature at the depth of 324 feet is 82.3° F.

OSTRICH RANCH WELL (SEC. 3, T. 1 N., R. 1 E.).

This is a 4-inch drilled well 170 feet deep with 110 feet of water. Water is raised either by windmill or engine as occasion demands. The pumping is intermittent, but the well is known to yield at least 35 gallons per minute. The full capacity is not known. No satisfactory record of the formation penetrated at this place could be obtained.

Analysis of water from Ostrich ranch well.

Quantitative (parts in 100,000):	
Total solids soluble at 110° C	130.00
Chlorine in terms of NaCl (common salt)	76.00
Hardness in terms of $CaSO_4$ (sulphate of lime)	8.20
Alkalinity in terms of Na_2CO_3 (black alkali)	None.
Qualitative:	
Sulplates	Very strong.
Magnesia	Distinct.
Lime	Strong.
Bicarbonates	Strong.

MOORE WELL (SEC. 11, T. 1 N., R. 1 W.).

The well of Mr. W. G. Moore is situated on the western border of the Agua Fria flood plain. It has been in operation since 1894, and irrigates 250 acres. The well is about 60 feet long and 20 feet wide, and has a maximum depth of 16 feet. The water, which is raised by a 6-inch Byron Jackson centrifugal pump, operated by a traction engine, is said to run at present about 110 inches (1,238 gallons per minute) continuously. More vigorous pumping drains the well. The water is the underflow of the Agua Fria, and the available quantity is directly dependent on the condition of this stream. From 1894 to 1902 a depth of 12 feet supplied a satisfactory quantity of water, but in 1902 the water was low, owing to a long drought, and the well was lowered 4 feet to secure the required amount of water. During the first four months of the present year (1903) the water has risen in the well 3.5 feet.

HEATON WELL (SEC. 15, T. 1 N., R. 1 W.).

Mr. John Heaton's well is 45 feet deep; the lower 33 feet is drilled and has a 6-inch casing. The dug part, 12 feet, is walled and cemented, and serves as a small reservoir. At the bottom is a horizontal suction pipe is attached to the well casing, and supplied with 4 common suction cylinders 5 inches in diameter; from each cylinder a small rod extends to an eccentric revolving shaft at the top of the well. The casing is fitted with a check valve to prevent any return of the water from the well reservoir down the casing pipe when the pumps are stopped. It is thus evident that while in operation the suction cylinders are 12 feet under water, and the 4 iron rods attached to the plungers work through this depth of water with considerable friction. The fourfold plunge pump is operated by an 8-horsepower gasoline engine, in which distillate is used in place of gasoline. The engine has a much greater capacity than the work demands, and runs at a proportionate disadvantage.

A careful computation of the cost of raising water in this manner was made and is given below. The depth from which the water is

lifted while the pump is in operation could not be measured accurately on account of the peculiar construction of the well. It is thought, however, from the behavior of other wells in the vicinity, that the lift does not vary greatly from the figure given below, 28 feet. Since the engine works automatically, there is no account taken of attendance.

Cost of raising water from John Heaton's well.

Cost of well	$100.00
Cost of engine and pump	$400.00
Interest on investment at 7 per cent per annum for 45 hours	$0.18
Depreciation at 10 per cent per annum for 45 hours	$0.26
Capacity of pump in gallons per minute	120
Number of hours to raise 1 acre-foot	45
Gallons of distillate used in a 10-hour run	13
Gallons of distillate used to pump 1 acre-foot	13.5
13.5 gallons of distillate at 25 cents	$3.38
Oil and repairs (estimated)	$0.05
Total cost per acre-foot	$3.87
Lift in feet	28
Average cost per foot in lifting 1 acre-foot of water	$0.138

Analysis of water from John Heaton's well.

Quantitative (parts in 100,000):	
Total solids soluble at 110° C	28.00
Chlorine in terms of NaCl (common salt)	5.20
Hardness in terms of $CaSO_4$ (sulphate of lime)	1.09
Alkalinity in terms of Na_2CO_3 (black alkali)	None.
Qualitative:	
Sulphates	Pronounced.
Magnesia	Pronounced.
Lime	Pronounced.
Bicarbonates	None.

HAYNE WELL (SEC. 1, T. 1 N., R. 1 W.).

L. C. Hayne's well is 11 by 7 feet and 24 feet deep, with 8 feet of water. Water is raised by a small steam engine and a 4-inch centrifugal pump, which is said to supply 50 inches of water (562 gallons per minute).

The well seems to be supplied by seepage from the irrigated area to the east. When irrigation is carried on extensively the water in the well is notably higher.

RICHARDSON DITCH (SEC. 15, T. 1 N., R. 1 W.).

Mr. Richardson has a seepage ditch near the mouth of the Agua Fria. The ditch cuts the water-bearing gravels for about three-fourths of a mile to a maximum depth of 10 feet. The water obtained is estimated at a maximum of 150 inches when the ditch is kept clear. Less than 50 inches were flowing at the time the ditch was visited. The accumulations of sand and algæ cause continuous work in keeping the

ditch clear. Mr. Richardson estimates that the constant work of a man and team is required in order to obtain the best results from the ditch.

Analysis of water from Richardson ditch.

	March 5, 1900.	April 21, 1900.
Quantitative (parts in 100,000):		
Total solids soluble at 110° C	30.00	33.4
Chlorine in terms of NaCl (common salt)	6.00	7.4
Hardness in terms of $CaSO_4$ (sulphate of lime)	None.	None.
Alkalinity in terms of Na_2CO_3 (black alkali)	1.17	1.3
Nitrogen in the form of nitrates	.126	.148
Nitrogen in the form of nitrites	.0032	Faint.
Qualitative:		
Sulphates	Very strong.	Strong.
Magnesia	Strong.	Strong.
Lime	Very strong.	Strong.

COOPER WELL (SEC. 16, T. 1 N., R. 4 E.).

Mr. J. D. Cooper has a small pumping plant north of Tempe. The well is 14 by 20 feet and 22 feet deep, with 4 feet of water. The water is raised by a 4-horsepower gasoline engine and bucket pump, which yields a supply estimated at 20 inches (Pl. VI). The well is in gravels, a few rods from the river bank, and the water comes from the flow of the river, which is here continuous.

THOMAS MURPHY WELL (SEC. 30, T. 2 N., R. 4 E.).

Mr. Thomas Murphy's well is located northeast of Phoenix, west of the Crosscut canal. It is a 6-inch well, 325 feet deep, and is one of the few wells of the region which reach bed rock. The sandstone and conglomerate shown in the log is probably the same as the sedimentary formation which occurs at Camelback Mountain, about 2 miles to the north, and in the buttes just east of the Crosscut canal, and which is described in Chapter II.

Log of Thomas Murphy's well No. 1.

	Feet.
Soil	4
Clay and cement	66
Gravel	3
Cement	5
Gravel, water bearing	37
Clay	27
Gravel	3
Conglomerate	31
Red sandstone	129
Shale	17
Sandstone	3

IRRIGATION BY MEANS OF BUCKETS AT J. D. COOPER'S PUMPING PLANT, NEAR TEMPE.

The conglomerate of this well should not be confused with the water-bearing gravels and bowlders so common in the valley-fill. The valley-fill is here only 140 feet deep; below this depth the material is consolidated red breccia, and can not be expected to yield water so readily as the unconsolidated gravels of the valley-fill.

Analyses have been made from water taken at 4 horizons at this place. The horizons are 78 feet (1), 168 feet (2), 187 feet (3), and 225 feet (4), respectively, below the surface. The water from the upper horizon—that from the 37-foot gravel bed—is strongly charged with sodium carbonate (black alkali), while the waters from the lower horizons are free from the alkali.

Analyses of water from Thomas Murphy's well No. 1.

	No. 1.	No. 2.	No. 3.	No. 4.
Quantitative (parts in 100,000):				
Total solids soluble at 110° C.	380.4	303.2	388.0	325.8
Chlorine in terms of NaCl (common salt)	140.0	136.0	105.0	123.4
Hardness in terms of $CaSO_4$ (sulphate of lime)	10.88	None.	None.	32.1
Alkalinity in terms of Na_2CO_3 (black alkali)	None.	2.70	45.16	None.
Nitrogen in the form of nitrates	2.33	.80	1.43	.66
Nitrogen in the form of nitrites	.40	None.	.0666	.0073
Qualitative:				
Sulphates	Very strong.	Very strong.	Very strong.	Very strong.
Magnesia	Very strong.	Very strong.	Very strong.	Very strong.
Lime	Very strong.	Very strong.	Very strong.	Very strong.

Another deep well is in process of construction by Mr. Thomas Murphy at the northern border of this section. At the present time it is 865 feet deep. Very little water-bearing material was encountered, as is shown in the log. It is worthy of note that the well penetrates red sandstone, presumably the red breccia exposed to the east and to the north, and that beneath the sandstones occurs soft clay. Where the red breccia is exposed at the surface it rests upon granite. This does not seem to be the case in the Murphy well. It is possible that the clay at the bottom is nothing more than soft shale, similar to the shale above, and that the drill worked it into a pliant mass not recognizable from unconsolidated clay. On the other hand it is possible that the clay penetrated by the Murphy-McQueen well at Mesa, and by the 705-foot Chandler well occurs at this place and is penetrated by the Thomas Murphy well.

Log of Thomas Murphy's well No. 2.

	Feet.
Cemented wash	160
Red sandstone	38
Shale and clay containing fragments of granite	225
Alternating layers of shale and sandstone	427
Soft clay	15

Since this is the deepest well in the valley—the Murphy-McQueen well having filled with sand for several hundred feet—a series of temperature observations were made, as follows:

Temperature of Thomas Murphy's well No. 2 at various depths.

Depth.	Temperature.	Time thermometer remained in well.	Remarks.
Feet.	*Degrees.*	*Hours.*	
100.....	74.6+	3	8 feet beneath the water. Temperature probably lowered by surface evaporation.
200.....	79.1+	3	Suspended in water.
300.....	79.8+	16	
400.....	80.0+	7	
500.....	80.6+	17	
600.....	81.1+	2	
700.....	81.9+	2	
800....	82.1+	2	
835.....	83.0+	20	In mud at bottom.

The observations indicate a moderately regular increase in temperature downward, although that increase is not so rapid as might be expected. No variation of temperature is caused here by circulation of water, as the water-bearing strata are cased off at the present time. Since no work has been done at the well for two months or more the recorded temperatures are evidently the true temperatures for the rock at the various depths.

The temperatures taken at intervals of 100 feet indicate an increase downward of 0.2° F. to 0.9° F. per 100 feet. Reckoned, however, from the basis of the average surface temperature, a very different rate is obtained. The average surface temperature at Phoenix, based on seven years' observation, is 69.3° F. There is, therefore, an increase downward of 14.7° F. in 835 feet, or an average increase of 1° F. for every 57 feet.

All things considered, this series of observations gives the most accurate record of the rate of increase of temperature downward of any observations obtained in this region, but since the well is not in the range of free circulation of Salt River underflow the temperature is not included in the table showing the temperature of that underflow, which is given in Chapter IV.

W. J. MURPHY WELL (SEC. 5, T. 2 N., R. 3 E.).

This is a 3-inch drilled well 128 feet deep with 18 feet of water. Water-bearing gravels were encountered at a depth of 110 feet and are at least 18 feet thick.

Log of W. J. Murphy's well.

	Feet.
Alternating sand, clay, and cement	110
Gravel and bowlders, water bearing	18

Analysis of water from W. J. Murphy's well.

Quantitative (parts in 100,000):	
Total solids soluble at 110° C	115.8
Chlorine in terms of NaCl (common salt)	35.6
Hardness in terms of $CaSO_4$ (sulphate of lime)	46.11
Alkalinity in terms of Na_2CO_3 (black alkali)	None.
Qualitative:	
Sulphates	Very strong.
Magnesia	Very strong.
Lime	Very strong.

MESSINGER WELL (SEC. 4, T. 2 N., R. 3 E.).

M. W. Messinger's well is drilled 175 feet deep and cased to the bottom, with no perforations. The water is 52 feet deep, having its surface 123 feet below ground surface. The available quantity of water was tested with a 12-horsepower engine and pump. The yield could not be learned, but when the pump was run at the greatest speed possible the water was lowered only 2 feet.

BEET-SUGAR FACTORY WELL (SEC. 8, T. 2 N., R. 2 E.).

A 6-inch well has been drilled at the beet-sugar factory now in process of construction near Glendale. The well is 117 feet deep and is designed only to furnish water for the construction work of the factory. The water is drawn from the gravels at the bottom of the well. It is under very little pressure, as it stands about 100 feet below the surface.

Log of well at beet-sugar factory, Glendale.

	Feet.
Soil	8
Sand and gravel	2
Clay	7
Cemented gravel	2
Clay	29
Cement	8
Cemented bowlders	16
Cement	14
Clay	19
Sand and gravel, water bearing	12

Analyses of water from well at beet-sugar factory, Glendale.

Quantitative (parts in 100,000):	
Total solids soluble at 110° C	54.60
Chlorine in the terms of NaCl (common salt)	15.50
Hardness in the terms of $CaSO_4$ (sulphate of lime)	None.
Alkalinity in the terms of Na_2CO_3 (black alkali)	1.99
Nitrogen in the form of nitrates	1.24
Nitrogen in the form of nitrites	.08

Qualitative:

Sulphates	Pronounced.
Magnesia	Faint.
Lime	Pronounced.
Bicarbonates	Strong.

BARTLETT WELL (SEC. 4, T. 2 N., R. 2 E.).

S. C. Bartlett's well, one of the first to be drilled in the region, was completed in 1892. It was 311 feet deep, but was cased with 4-inch pipe to a depth of only 70 feet. No log of the well was preserved, but Mr. A. J. Straw, who was managing the Bartlett ranch at the time the well was put down, stated that the first water struck was at the depth of 120 feet. A second water-bearing stratum was penetrated at a depth of about 185 feet, and a third at the bottom of the well—311 feet.

This well has been of great interest in the community on account of certain indications which lead to the supposition that water is to be found under sufficient pressure to make flowing wells. Mr. Straw, who is himself an experienced well driller, and has put down a large number of the wells near Phoenix, said that at a depth of 311 feet the drill struck a very hard layer, on which the drilling machinery employed was not strong enough to have much effect. After pounding for about two hours the water is said to have suddenly spurted from the well, rising about 7 feet above the top of the casing. The upward rush of the water lifted the drill and operations were stopped. The water flowed from the well for a few moments, then gradually ceased. The next morning the drill was started again and the water is said to have again spurted from the top of the pipe as before, and operations were discontinued, the drilling machinery being inadequate to cope with the difficulty.

Water enough was obtained to supply all needs at the time and nothing further has been done to the well. Since the casing reaches only to a depth of 70 feet, the lower portion of the well soon filled and the water is now derived presumably from the upper or 120-foot horizon.

ALKIRE WELLS (SEC. 21, T. 2 N., R. 2 E.).

Frank Alkire has two drilled wells in this locality. The last one was completed in 1903; it is a 6-inch well 96 feet deep. No water worthy of mention was encountered until the well reached a depth of 96 feet, when a gravel bed was entered, which yields all the water desired. This water was confined by a hard layer of cement.

Log of Frank Alkire's well near Phoenix.

	Feet.
Soil	22
Sand and gravel, dry	6
Clay, sand, and cement	27
Gravel, a little water	10
Cement	1
Bowlders, water bearing	?

Analysis of water from Frank Alkire's well, near Phoenix.

Quantitative (parts in 100,000):	
Total solids soluble at 110° C	41.1
Chlorine in terms of NaCl (common salt)	10.0
Hardness in terms of $CaSO_4$ (sulphate of lime)	Strong.
Alkalinity in terms of Na_2CO_3 (black alkali)	None.
Nitrogen in the form of nitrates	.0004
Nitrogen in the form of nitrites	1.5

SILVA WELL (SEC. 15, T. 2 N., R. 2 E.).

Mr. Alexander Silva's well is dug 100 feet and drilled 35 feet. The water stands 95 feet below the surface. Some water was found in black sand at a depth of 103 feet, but no satisfactory supply was obtained until gravel was reached at a depth of 110 feet. The water from this gravel bed flows continually from the top of the pipe into the open or dug part of the well and leaks back again in the stratum of sand above.

Log of Alexander Silva's well near Phoenix, Ariz.

	Feet.
Soil	12
Sand and gravel	6
Alternating layers of cement, clay, and sand	72
Quicksand	6
Hard cement	7
Black sand	4
Clay	9
Sand, gravel, and bowlders, water bearing	16

MILLER WELL (SEC. 33, T. 2 N., R. 2 E.).

Edward Miller has a 4-inch drilled well 78 feet deep, with 24 feet of water. A stream of salt water was encountered at a depth of 50 feet. Beneath the salt water a stratum of cement occurs, beneath which is a sand yielding a satisfactory supply of good water. This water is under slight pressure and rose a few feet when struck.

Log of Edward Miller's well near Phoenix, Ariz.

	Feet.
Sandy soil	16
Bowlders, dry	4
Cement, sand, and clay	30
Gravel, salty water	3
Cement	?
Sand, water bearing	?

HOUGH WELL (SEC. 6, T. 2 N., R. 2 E.).

Mr. Samuel Hough has a 6-inch drilled well 105 feet deep, with 15 feet of water. For 95 feet the material is sand, clay, and gravel, more or less cemented; for the lower 10 feet it is uncemented gravel. The material is sufficiently firm to stand without casing, and the well is cased only a few feet from the top. It has been in use since 1899.

A. H. SMITH WELL (SEC. 21, T. 2 N., R. 2 E.).

A. H. Smith's well was dug 96 feet deep and had originally 13 feet of water, probably derived from the gravel bed reached by other wells of the vicinity, though this can not be definitely stated. At a depth of 96 feet the well was in a hard cement which required blasting; after the blast the workman descended but found the water 13 feet deep in the well, and nothing further has ever been done. The water is used only for domestic purposes, but the supply seems to be abundant.

Analysis of water from A. H. Smith's well.

Quantitative (parts in 100,000):

Total solids soluble at 110° C	130.5
Chlorine in the terms of NaCl (common salt)	40.0
Hardness in the terms of $CaSO_4$ (sulphate of lime)	Strong.
Alkalinity in the terms of Na_2CO_3 (black alkali)	None.
Nitrogen in the form of nitrates	10.0
Nitrogen in the form of nitrites	.012

GLENDALE TOWN WELL (SEC. 8, T. 2 N., R. 2 E.).

This is a 6-inch drilled well 112 feet deep, and contains 12 feet of water. It was put down in 1894 and has yielded a satisfactory supply of water ever since that time.

Analysis of water from the Glendale town well, Glendale, Ariz.

Quantitative (parts in 100,000):

Total soluble solids at 110° C	79.2
Chlorine in terms of NaCl (common salt)	39.0
Hardness in terms of $CaSO_4$ (sulphate of lime)	Strong.
Alkalinity in terms of Na_2CO_3 (black alkali)	None.
Nitrogen in the form of nitrates	None.
Nitrogen in the form of nitrites	.0003

HAMILTON WELL (SEC. 5, T. 2 N., R. 2 E.).

Mr. H. W. Hamilton has a 6-inch drilled well 120 feet deep, with 7 feet of water. Water-bearing gravels were encountered at a depth of 119 feet.

Analysis of water from H. W. Hamilton's well.

Quantitative (parts in 100,000):	
Total solids soluble at 110° C	115.80
Chlorine in terms of NaCl (common salt)	35.60
Hardness in terms of $CaSO_4$ (sulphate of lime)	46.11
Alkalinity in terms of Na_2CO_3 (black alkali)	None.
Qualitative:	
Sulphates	Very strong.
Magnesia	Very strong.
Lime	Very strong.
Bicarbonates	No trace.

J. P. ORME WELL (SEC. 25, T. 2 N., R. 1 E.).

Mr. J. P. Orme's well is dug 74 feet deep. At a depth of 44 feet gravels were encountered which yielded a little water, but the supply was not satisfactory and the well was deepened. At a depth of 72 feet a loose gravel bed was found which yielded a large supply, the water rising 26 feet and remaining near that level since the well was dug in 1885. The well is now filled to some extent so that the water does not actually measure 26 feet. The water from the lower gravels is said to be much better in quality than that which comes from higher horizons.

Log of J. P. Orme's well, near Phoenix.

	Feet.
Soil	18
Loose gravel and sand	12
Cement	14
Loose gravel and sand, little water	15
Cement	13
Gravel, water bearing	2

L. B. ORME WELL (SEC. 35, T. 2 N., R. 1 E.).

L. B. Orme has a 4-inch drilled well 102 feet deep. The material to a depth of 76 feet is clay, sand, and cement, yielding no satisfactory water supply. At 76 feet a gravel bed was encountered from which the water rose 14 feet—to within 62 feet of the surface.

Log of L. B. Orme's well, near Phoenix.

	Feet.
Soil	6
Sand and gravel	6
Soil	10
Alternating layers of cement, clay, and sand	54
Gravel and bowlders, water bearing	26

BURROWS WELL (SEC. 35, T. 2 N., R. 1 W.).

Dr. C. Burrows's well, which is 10 feet square and 25 feet deep, is a seepage well in the sands and gravels of the Agua Fria. It was in use from 1896 to 1900. Water was raised by steam power and a centrifugal pump, which furnished a continuous stream of 150 inches (1,680 gallons per minute). No use has been made of the well since 1900.

WIEDER WELL (SEC. 32, T. 3 N., R. 3 E.).

J. A. Wieder's well is drilled 146 feet deep. Near the bottom is a sand stratum that yields the water, which is 17 feet deep and of good supply. The windmill with which the well is supplied has not been able to exhaust the supply even in the strongest winds. The well is not cased, and yet in the six years since it was drilled only 1 foot of sand has accumulated at the bottom, the material through which it is drilled being almost entirely composed of the coarse angular wash from the hills. No waterworn gravels were encountered.

Analysis of water from J. A. Wieder's well.

Quantitative (parts in 100,000):	
Total solids soluble at 110° C	76.1
Chlorine in terms of NaCl (common salt)	31.5
Hardness in terms of $CaSO_4$ (sulphate of lime)	Strong.
Alkalinity in terms of Na_2CO_3 (black alkali)	None.
Nitrogen in the form of nitrates	.70
Nitrogen in the form of nitrites	.0078

FOWLER WELL (SEC. 33, T. 3 N., R. 2 E.).

Mr. B. A. Fowler has a 6-inch drilled well 133 feet deep with 8 feet of water. The well was drilled in 1899. No accurate log of the well was kept, but the presumption is that the water comes from a depth of 133 feet.

Analysis of water from B. A. Fowler's well.

Quantitative (parts in 100,000):	
Total solids soluble at 110° C	80.9
Chlorine in terms of NaCl (common salt)	13.2
Hardness in terms of $CaSO_4$ (sulphate of lime)	36.5
Alkalinity in terms of Na_2CO_3 (black alkali)	None.

COLE WELL (SEC. 31, T. 3 N., R. 2 E.).

This well is dug 125 feet deep. The material is alternating layers of sand, clay, and cement for 123 feet, when a water-bearing sand is encountered. Two feet deeper a strong flow was struck from which the water rose 19 feet, where it has remained practically constant since 1896, when the well was dug.

Log of N. O. Cole's well, near Phoenix.

	Feet.
Alternating layers of sand, clay, and cement	123
Sand and gravel, water bearing	2

TABULATION OF WELLS FOR PHOENIX REGION.

Many wells in the Phoenix region were visited in addition to those described. In most cases nothing was found worthy of special description, and the measurements were placed directly on the map for construction of the water table. In other cases meager information was obtained, as indicated in following table:

Well records of the Phoenix region.

[Data gathered in part by various members of R. W. Hawley's survey party.]

Number.	Owner.	Post-office.	Location. Township.	Range.	Section.	Completed.	How put down.	Depth of well.	Depth to water.	Did water rise when struck?	Elevation of surface.	Elevation of water.
								Feet.	*Feet.*		*Feet.*	*Feet.*
	Phoenix Water Co. (2 shallow and 3 drilled wells)	Phoenix	1 N.	3 E.	4	1902	Drilled	208	40	No	1,092	1,052
1	G. W. Barnard	Tempe	1 N.	3 E.	8	1896	Dug	28	21	No	1,143	1,122
	Arizona Laundry Co	Phoenix	1 N.	3 E.	8	1900	do	35	32	No	1,087	1,055
	City Park	do	1 N.	3 E.	9	1902	do	42	31	No	1,092	1,061
	Lewis Wetzler	do	1 N.	3 E.	11	1900	do	40	25	No	1,113	1,088
	Frank Wagner	do	1 N.	3 E.	16	1902	do	35	27	No	1,091	1,064
	L. Kunz	do	1 N.	3 E.	18	1899	do	24	18	No	1,063	1,045
	A. C. Bartlett	do	1 N.	3 E.	27	1901	do	42	34	No	1,103	1,061
	William Christy	do	1 N.	2 E.	1	1902	Drilled	45	37	Yes		
	J. J. Harris	do	1 N.	2 E.	6	1901	do	103	30	Yes	1,046	1,016
	I. L. Brown	do	1 N.	2 E.	13	1901	do	19	13			
	Nelson & McIlwaine	do	1 N.	2 E.	15		Dug	20	14	No	1,048	1,034
	J. R. Bradshaw	do	1 N.	2 E.	15	1900	do	27	19	No		
	George U. Collins	do	1 N.	2 E.	15	1901	do	29	14	No	1,043	1,029
	William H. Perry	do	1 N.	2 E.	22	1903	do		14	No	1,038	1,024
	N. P. McCallum	do	1 N.	2 E.	24	1903	Drilled		14	No	1,051	1,037
24	W. W. Messinger	do	2 N.	3 E.	4	1899	do	175	123	Yes	1,207	1,184
23	F. L. Howard	do	2 N.	3 E.	4	1900	do	175	127	Yes	1,198	1,071
25	Thos. S. Wallin	do	2 N.	3 E.	5	1890	Dug	104	100	No	1,179	1,079
26	Mrs. A. Allen	do	2 N.	3 E.	5	1898	Drilled			No	1,194	
27	W. J. Murphy	do	2 N.	3 E.	5	1897	do	130	110		1,197	1,087
19	—— Barney	Glendale	2 N.	3 E.	6	1897	do	96	95			
29	Harry Thompson	Phoenix	2 N.	3 E.	8	1899	do	104	94	Yes	1,175	1,081
28	J. M. Jamison	do	2 N.	3 E.	8	1897	Dug	125	94		1,173	1,079

Well records of the Phoenix region—Continued.

Number.	Owner.	Post-office.	Location. Township.	Range.	Section.	Completed.	How put down.	Depth of well.	Depth to water.	Did water rise when struck?	Elevation of surface.	Elevation of water.
								Feet.	*Feet.*		*Feet.*	*Feet.*
20	G. F. Houghton	Phoenix	2 N.	3 E.	15	1901	Drilled	98	78	Yes	1,159	1,081
21	Mrs. K. Young	do	2 N.	3 E.	15	1902	Dug	100	95	Yes	1,174	1,079
22	do	do	2 N.	3 E.	15		Drilled	101	88	No	1,159	1,071
	Indian School	do	2 N.	3 E.	20	1903	do	193	36		1,115	1,079
19	Smith & Raney	do	2 N.	3 E.	22	1898	do	90	70	No	1,153	1,083
16	H. H. Munger	do	2 N.	3 E.	23	1899	Dug	83	81	Yes	1,177	1,096
17	C. W. Perkins	do	2 N.	3 E.	23	1901	Drilled	154	82	Yes	1,184	1,102
18	W. D. Bell	do	2 N.	3 E.	23	1902	do				1,171	
8	A. M. Fredrick	do	2 N.	3 E.	27	1883	Dug	56	52	Yes	1,120	1,068
9	B. R. Ellison	do	2 N.	3 E.	27	1901	do	52	50	No	1,123	1,073
7	R. R. Hedgepath	do	2 N.	3 E.	27	1901	do	45	43	Yes	1,117	1,074
13	Elva Hasford	do	2 N.	3 E.	27		do	53	52		1,136	1,084
14	Lee Barnett	do	2 N.	3 E.	27	1901	Drilled	54	37	No	1,133	1,096
15	—— Anderson	do	2 N.	3 E.	27		Dug	58	57	No	1,129	1,071
11	—— McFall	do	2 N.	3 E.	27	1883	do	47	43	No	1,128	1,086
10	J. E. Tounehill	do	2 N.	3 E.	28	1883	do	50	44	No	1,123	1,079
49	L. Perkins	do	2 N.	3 E.	29	1887	do	40	36	No	1,096	1,060
56	Dr. Stone	do	2 N.	3 E.	29	1902	do	53	35	No	1,098	1,063
44	R. B. Quinn	do	2 N.	3 E.	30	1893	Drilled	80	40	No	1,096	1,056
46	—— Warren	do	2 N.	3 E.	30	1888	do	80	40	No	1,105	1,065
48	S. Evans	do	2 N.	3 E.	30	1893	Dug	42	38	No	1,101	1,063
50	C. M. Baum	do	2 N.	3 E.	30	1886	do	43	37	No	1,096	1,059
33	R. H. Green	do	2 N.	3 E.	30	1893	do	50	45	No	1,112	1,067
34	W. T. Cage	do	2 N.	3 E.	30	1902	do	35	33	No	1,112	1,070
36	H. C. Buford	do	2 N.	3 E.	30	1893	do	33	32	No	1,107	1,075
38	C. E. Kirk	do	2 N.	3 E.	30	1900	do	45	41	No	1,105	1,064

51	L. H. Chamler	do	2 N.	3 E.	32	1902	do	37	29	No	1,089	1,060
52	G. F. Kemper	do	2 N.	3 E.	32	1889	do	46	26	No	1,088	1,062
53	J. R. Evans	do	2 N.	3 E.	32	1902	do	35	31	No	1,088	1,057
55	J. P. Orme	do	2 N.	3 E.	32	1884	do	50	30	No	1,089	1,059
57	W. E. Thomas	do	2 N.	3 E.	32	1890	do	51	30	No	1,096	1,068
	A. C. Bartlett	do	2 N.	3 E.	32	1900	do	44	28	No	1,087	959
	D. B. Heard	do	2 N.	3 E.	32	1901	Drilled	42	26	No	1,092	1,066
2	Thos. Armstrong	do	2 N.	3 E.	33	1902	Dug	44	40	No	1,110	1,070
3	John Horrineg	do	2 N.	3 E.	34	1886	do	57	53	No	1,128	1,075
4	Anna Anderson	do	2 N.	3 E.	35	1894	do	50	46	No	1,128	1,082
5	M. F. White	do	2 N.	3 E.	35	1888	do	54	52	No	1,124	1,072
18	M. B. Laymon	Glendale	2 N.	2 E.	1	1896	Drilled	104	86			
19	E. Fiscall	do	2 N.	2 E.	1	1897	do	96	89	Yes	1,210	1,119
	S. C. Bartlett	do	2 N.	2 E.	4	1892	do	311		Yes	1,180	
	H. W. Hamilton	do	2 N.	2 E.	5	1899	do	120	113		1,176	1,063
13	John Toney	do	2 N.	2 E.	5		do	108	92	Yes	1,156	1,064
	Saml. Haugh	do	2 N.	2 E.	6	1899	do	105	90	Yes	1,120	1,030
	E. T. Hawkins	do	2 N.	2 E.	6	1899	do	112	91		1,155	1,064
7	Beet-sugar factory	do	2 N.	2 E.	8	1903	do	117	105	Yes	1,163	1,058
	Alexander Silva	Phoenix	2 N.	2 E.	15	1899	Dug	135	95	Yes	1,157	1,062
	A. H. Smith	Alhambra	2 N.	2 E.	21	1897	do	91	82	Yes	1,138	1,056
	Frank Alkire	Phoenix	2 N.	2 E.	21	1903	Drilled	96			1,135	
	Elliot Evans	do	2 N.	2 E.	25	1902	Dug	68	64	No	1,109	1,045
	—— Corness	do	2 N.	2 E.	29	1902	do	60	58	No	1,086	1,028
	J. M. Pike	do	2 N.	2 E.	32	1886	do	64	52	Yes	1,079	1,027
	Edward Miller	do	2 N.	2 E.	33	1899	Drilled	78	54	Yes	1,092	1,038
	Jacob Miller	do	2 N.	2 E.	33	1900	do	133	60	Yes	1,086	1,020
	Chris Miller	do	2 N.	2 E.	34		do	72	47	Yes	1,093	1,046
11	W. Pope	do	2 N.	1 E.	9	1900	Dug	40	38	Yes	1,074	1,036
13	—— Young	do	2 N.	1 E.	9	1890	do	40	38	Yes	1,035	997
4	W. H. Brown	Alhambra	2 N.	1 E.	14	1898	do	80	68	Yes	1,086	1,018
8	—— Pendergrast	Phoenix	2 N.	1 E.	16	1900	do	50	47	Yes	1,057	1,010
16	—— Simpson	do	2 N.	1 E.	21	1899	do	63	59	Yes	1,047	988
17	H. M. Wilburn	do	2 N.	1 E.	22	1903	Drilled	71	56	Yes	1,064	1,008
7	J. D. Hawkins	Alhambra	2 N.	1 E.	22	1893	Dug	60	56	Yes	1,069	1,013

Well records of the Phoenix region—Continued.

Number.	Owner.	Post-office.	Location. Township.	Location. Range.	Location. Section.	Completed.	How put down.	Depth of well.	Depth to water.	Did water rise when struck?	Elevation of surface.	Elevation of water.
								Feet.	*Feet.*		*Feet.*	*Feet.*
5	M. S. Rogers	Phoenix	2 N.	1 E.	22	1888	Dug	70	58	Yes	1,074	1,016
3	R. O. Green	do	2 N.	1 E.	23	1890	do	76	38	Yes	1,089	1,051
18	W. H. Wilke	Alhambra	2 N.	1 E.	23	1888	do	68	60	Yes	1,077	1,017
1	—— Green	Phoenix	2 N.	1 E.	25	1896	do	70	67	Yes	1,087	1,020
	Mrs. Wilke	do	2 N.	1 E.	25	1896	do	73	57	Yes	1,091	1,034
	J. P. Orme	do	2 N.	1 E.	25	1885	do	74	58	Yes	1,075	1,017
	J. J. Meyer	do	2 N.	1 E.	26		do	63	59	No	1,065	1,006
	L. B. Orme	do	2 N.	1 E.	35	1900	Drilled	102	62	Yes	1,060	998
	J. A. Wieder	do	3 N.	3 E.	32	1897	do	146	139	No	1,214	1,075
	W. H. Bartlett	Glendale	3 N.	2 E.	30	1891	Dug	132	116		1,181	1,064
	N. O. Cole	do	3 N.	2 E.	31	1896	do	125	106	Yes	1,165	1,059
	B. A. Fowler	Phoenix	3 N.	2 E.	33	1899	Drilled	133	125	No	1,192	1,067
18	—— Woolsey	Peoria	3 N.	1 E.	14	1899	do	93	85	Yes	1,157	1,072
	A. J. Straw	do	3 N.	1 E.	25	1898	do	100	86	Yes	1,157	1,071
1	E. D. Clark	do	3 N.	1 E.	26	1889	Dug	90	86	Yes	1,141	1,055
2	R. H. Tuckey	do	3 N.	1 E.	26	1903	Drilled	93	76	No	1,130	1,054
14	R. W. Wagner	Glendale	3 N.	1 E.	36	1895	Dug	97	82	Yes	1,137	1,055

CHAPTER II.

GEOLOGY.

The formations within the area covered by the accompanying geologic map (Pl. VII) are limited in number, owing to the fact that the only map of the region available for use in showing the areal distribution of the geologic formations, was constructed primarily as a map of irrigable lands. In order to obtain a correct conception of the geologic relations of the valley, something of the surrounding hills must be known. For this reason a brief description of the formations occurring near Salt River Valley is included with those represented on the map.

PRE-CAMBRIAN ROCKS.

A small area of the Archean complex is included in the region shown on the map north of Tempe and in Camelback Mountain. The rock is mainly granite and gneiss, intersected in numerous places by dikes, most of which are highly decomposed. Outside the valley the granites are extensively exposed in the surrounding hills. In the Salt River Mountains, south of Phoenix, a fine-grained biotite-granite occurs, which is being used successfully as an ornamental stone. Granite occurs in large masses in the Sacaton Mountains, southeast of Salt River Valley and in the mountains to the east and the north. The granites, particularly to the east, are very coarse grained, the feldspars often attaining a diameter of 2 inches. The rock disintegrates in the arid climate of Arizona to a coarse-grained arkose, commonly known in this region as granitic wash.

Three samples of rock, so chosen that they are representative of the granites in and about Salt River Valley, have been described by J. E. Spurr, of the United States Geological Survey, as follows:

No. 1. Mountains south of Salt River and east of Mesa, Ariz., coarse, siliceous biotite-granite. Structure—hypidiomorphic, granular, with a tendency to idiomorphism, suggesting at times a micro-pegmatitic structure. This rock contains abundant quartz; orthoclase containing a great deal of sericite, probably a decomposition product; microline; and an undetermined finely striated feldspar, which is very likely albite. There is also frequent biotite, almost entirely altered to chlorite and epidote, with abundant titanite, and considerable original magnetite. The whole rock shows the effects of weathering markedly, but is not profoundly decomposed.

No. 2. Same locality as No. 1. Siliceous granite, similar to No. 1. Structure—coarse, hypidiomorphic; contains orthoclase, including much sericite, probably sec-

ondary; quartz contemporaneous in general with the feldspar, but largely segregated in veinlike bodies; abundant epidote and chlorite. Titanite is relatively abundant. The rock shows the effect of weathering to a considerable extent.

No. 3. From head-gate of Consolidated canal. Siliceous biotite-granite. Structure—irregular, coarse to fine, hypidiomorphic, granular, in part poikilitic; contains orthoclase, partly kaolinized; microline slightly decomposed to sericite and kaolinic decomposition products, and a striated feldspar whose optical properties show it to be very siliceous, probably anorthoclase. The abundant biotite is fairly fresh; quartz is present in large quantity; fine muscovite occurring in the orthoclase in flakes may be secondary, but is probably original; original magnetite is present; titanite is in large and abundant crystals.

This rock, although a different facies from Nos. 1 and 2, is of the same petrographic character, and all can very easily belong to a single rock mass or intrusion. The condition of this rock is fairly fresh.

In addition to the granites there are extensive series of gneisses in the hills surrounding the valley. The granites pass into the gneisses by imperceptible gradations. Rocks occur in which the feldspars are but slightly deformed, while others reveal a highly gneissoid structure. Bands of gneiss were noted in several places in the midst of granites which show little or no gneissoid structure, probably where movement has occurred along lines of least resistance, while the more resistant masses remained unchanged.

In the Phoenix Mountains, immediately north of the city of Phoenix, occurs an extensive series of metamorphosed sediments, many thousands of feet in thickness (Pl. VIII, *A* and *B*). The layers rest in a nearly vertical position. The quartzite which makes up a large proportion of this series has probably furnished many of the quartzite bowlders of the valley fill, which are described later.

In the Tonto basin east of Salt River Valley an extensive series of quartzites, argillites, etc., occur, which, although they are pre-Cambrian are much less disturbed and less altered than the sedimentaries of Phoenix Mountains (Pl. IX). The pre-Cambrian series of Tonto basin is probably the Apache group of Ransome.[a] Dr. Charles D. Walcott refers this formation to the Algonkian. He writes regarding the relations at the Tonto dam site:

> The Carboniferous limestones rest directly and unconformably upon the quartzites and argillites of the Algonkian.[b]

The formation is composed throughout of extremely resistant rock, forming an escarpment in which the strata are nearly horizontal, as in the Sierra Ancha (Pl. IX, *B*), overlooking the Tonto basin, or forming a ridge where the strata are tilted, as in the ridge through which Salt River has cut its gorge at the Tonto dam site (Pl. IX, *A*, and fig. 11).

[a] Ransome, F. L., Geology of the Globe copper district, Arizona: Prof. Paper U. S. Geol. Survey No. 12, 1903, pp. 28-39. Geology of Globe quadrangle: Geologic Atlas U. S., folio 111, U. S. Geol. Survey, 1904.

[b] Personal communication.

A. TILTED PRE-CAMBRIAN QUARTZITES AND ARGILLITES IN THE PHOENIX MOUNTAINS.

B. PHOENIX PEAK, NORTH OF PHOENIX.

A. SALT RIVER DAM SITE, LOOKING UPSTREAM INTO TONTO BASIN.

The rock is Algonkian quartzites and argillites dipping upstream. Photograph by Walter Lubkin.

B. SIDE CANYON IN TONTO BASIN.

Showing the nature of the quartzites and argillites of the Algonkian strata of the Sierra Ancha.

The thickness of this formation as exposed in this gorge is about 1,800 feet. In the Sierra Ancha the same formation is seen and seems to be much thicker. It is extensively exposed along Salt

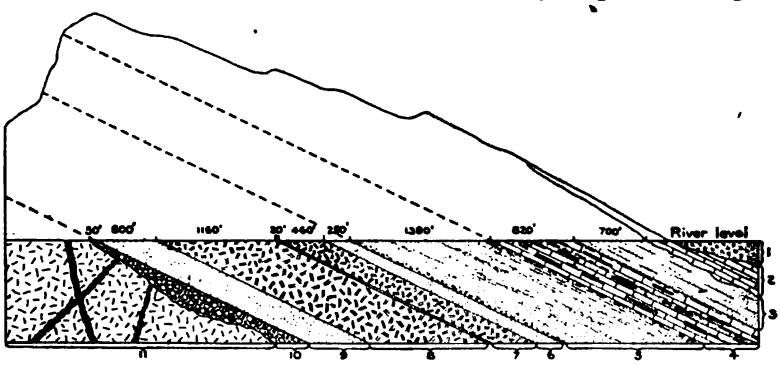


FIG. 11.—Section through Salt River gorge at the Tonto dam site.

River, east of Tonto basin, and has probably furnished the greater portion of the gravel and bowlders of the valley fill of Salt River Valley.

CARBONIFEROUS ROCKS.

The formation next younger than the Apache, so far as known in the vicinity of Salt River Valley, is the lower Carboniferous. Fossiliferous limestones rest upon the Apache group in the Tonto basin, and have yielded the following fossil forms:

Fossils from limestone at Tonto basin dam site.

Zaphrentis sp.	Productus lævicosta.
Menophyllum excavatum.	Spirifer centronatus.
Syringopora surcularia.	Spirifer sp.
S. aculeata.	Camarotœchia metallica.
Leptopora typa.	Platyceras sp.
Rhipidomella sp.	Bellerophon sp.
Schuchertella inæqualis.	Fish tooth.

Fossils from limestones near Tonto basin dam site.

Zaphrentis sp.	Leptopora typa.
Menophyllum excavatum.	Rhipidomella sp.
Cyathophyllum sp.	Schuchertella inæqualis.
Syringopora surcularia.	Spirifer centronatus.

Fossils from limestone at Windy Hill, Tonto basin.

Menophyllum excavatum.	Crinoidal fragments.
Cyathophyllum sp.	Spirifer centronatus.
Syringopora aculeata.	Seminula humilis ?
Leptopora typa.	

These fossils were identified by George H. Girty, paleontologist of the United States Geological Survey, who refers the formation to the Lower Carboniferous. The fossils are identical with those found in the Redwall limestone of the Grand Canyon section. In writing of the fauna, Mr. Girty says:

> The opinion is expressed with considerable confidence that the faunas represent the earlier half of Mississippian time. The fauna is that which has a wide range throughout the West, having been found in almost every State east of the Sierra Nevadas. It characterizes the Madison limestones of Wyoming and Montana, the Ouray limestones of Colorado (in its upper portion), the lower part of the Wasatch limestones of Utah, etc. The fauna resembles that of the Kinderhook and Osage divisions of the Mississippi Valley section.

TERTIARY (?) DEPOSITS.

SEDIMENTARY ROCKS.

It is not certainly known that any Mesozoic strata are represented in or near Salt River Valley. Near Tempe occur several isolated exposures of red sandstones, conglomerates, and breccias, of which a thickness of about 200 feet is exposed at Tempe Butte. The base is a massive sandstone, used in the valley for building purposes. The sands become more and more argillaceous toward the top, where red shale underlies the lava capping the butte. These strata dip 55° to the southeast and strike N. 60° E.

North of the river at Tempe occurs a series of red sandstones passing downward through a coarse arkose to a granitic breccia at the base. The formation is apparently a continuation of the sandstones of Tempe Butte, although it dips southwest 65° (strike N. 40° W.), nearly at right angles to the direction of dip at the Butte. This formation apparently extends little more than a mile north of the river, although this can not be confidently stated on account of the fragmental débris which covers the greater part of the surface. A well about 1.5 miles northwest of Tempe is in sandstone to the depth of about 200 feet, while a well 2.5 miles northwest of Tempe is entirely in granite to the depth of 110 feet. The attitude of the sandstones both north and south of the river is best explained by faulting, but the fault planes are entirely obscured by surface débris. The sandstone is shown in Pl. XII. Nothing has been found to indicate its age.

In the buttes north of Tempe (Pl. XI, *B*) and on the western slope of Camelback Mountain (Pl. XI, *A*) occurs a formation composed of arkose sandstone, breccia, and conglomerate. It is coarse and massive and indicates only the roughest kind of bedding. It rests upon an uneven surface of granite and the base is composed wholly of fragmental granite. Higher in the series other constituents enter. Quartz, quartzite, jasper, and a number of species of igneous rocks were noted. In places the pebbles are well rounded, forming a conglomerate.

A. CAMELBACK MOUNTAIN, NEAR PHOENIX.

Showing breccia at the left, resting on the flank of a granite mountain.

B. BUTTES NORTH OF TEMPE.

but on the whole the material is sharply angular. The base is not well defined. The massive granite gives place to a granitic agglomerate scarcely separable from the unbroken granite beneath, and this agglomerate passes upward into conglomerate, breccia, and arkose sands according to locality. In Pl. XI, *A*, granite is shown at the right, and massive granoclastics at the left, passing upward to stratified breccia.

The sandstone and breccia of the Tempe region are similar in being red, arkose, and devoid of fossil forms. It is possible that they form a single series passing from the granoclastic mass at the base through the breccias and sandstones to the shale at the top. They are not found in actual contact, and are apparently unconformable. The breccia seems to lie across the upturned sandstone, and upon the granite beyond. It is probable that the sandstone, together with the granite against which it rests, was upturned and deeply eroded previous to the deposition of the breccia.

Owing, no doubt, to their resemblance in color and texture to the Triassic sandstones occurring elsewhere, these two formations have been referred to the Trias. Professor Blake[a] refers to them briefly as follows:

> Formations of the Mesozoic are not absent in southern Arizona. The massive red sandstones north of Phoenix, of Tempe, and of Mesa in Salt River Valley are referred to the Trias.

In fig. 17 I have attempted to show in a general way the relation of Salt River Valley to the great continental plateau. It is probable that the sedimentary formations (pre-Cambrian and Carboniferous) forming the escarpment, and the mountain ridge at the Tonto dam site, formerly extended over Salt River Valley, and were carried away by erosion after the elevation of the plateau. In that case a formation resting in contact with the pre-Cambrian formations of the valley can scarcely be of Triassic age. The well-known Triassic of Arizona is found on the top of the plateau, being thus elevated when the plateau was raised. If the supposition is correct that the low-lying area beyond the edge of the plateau, of which Salt River Valley is a part, is in large measure due to degradation subsequent to the elevation of the plateau, any formation resting on that degraded surface must be later than the period of degradation. The elevation of the plateau began, so far as known, at the end of the Cretaceous period. A long period of erosion must have elapsed subsequent to the elevation of the plateau before the sandstone and breccia were laid down. For these reasons the breccia is thought to be not older than late Tertiary, and may indeed be equivalent to the Gila conglomerate, which Gilbert regards as early Quaternary. Beyond the suggestion that the sand-

[a] Blake, William P., Some salient features in the geology of Arizona with evidences of shallow seas in Paleozoic times: Am. Geol., March, 1901, p. 166.

stone and breccia may be phases of a single accumulation, the age of the sandstone must remain an open question.

Judging from the character of the breccia and its relation to older rocks, there is little doubt that it is due to upland accumulations. The size of some of the granite blocks—many of them several feet in diameter—indicates that action was violent and granite highlands not far distant when the breccia was formed. In general character the breccia closely resembles the Gila conglomerate of Gilbert. On the other hand it is evident from the remnants left in the valley that this breccia formerly had a wide areal distribution and that the greater part of it has been carried away. All things considered it seems preferable to refer the formations exposed at Tempe tentatively to late Tertiary.

TERTIARY LAVAS.

Eruptive rocks occur within Salt River Valley in Bell Butte (see Pl. XIII, *A*), Tempe Butte, and a line of small buttes north of Tempe. The rock from Bell Butte is described by J. E. Spurr as follows:

Butte southwest of Tempe, Ariz.: Hornblende-pyroxene-andesite, fine grained. Structure—fine porphyritic. Phenocrysts of pale-brown basaltic hornblende, altered along the edges to calcite and iron; pseudomorphs of calcite and iron oxide after pyroxene; and turbid feldspars which are altered chiefly to calcite, indicating their belonging to the soda-lime group. The groundmass is glassy, in part microlithic, and shows altered feldspars, etc. This rock is highly altered.

In the hills surrounding the valley occur extensive masses of eruptive rock, consisting of rhyolite, andesite, basalt, volcanic glass, pearlite, ash, scoria, etc. The most extensive mass in the immediate environs of the valley is found in the Superstition Mountains, east of Salt River Valley, where rhyolitic flows and beds of white tuff and ash occur to an aggregate thickness of several thousand feet. The igneous rocks form a nearly vertical escarpment rising something over 5,000 feet above the valley floor (Pl. XIII, *B*).

QUATERNARY FORMATIONS.

The greater part of the area represented in the accompanying geologic map is occupied by débris which is here designated "valley fill." It is unconsolidated material, accumulated in the valleys and on the gentler slopes of the hills. Since it is in this valley fill that the underground water occurs, it is, so far as this report is concerned, the formation of prime importance in the region. An understanding of processes of accumulation now in operation is necessary for an adequate understanding of certain features in the structure of the valley fill. For this reason much that properly belongs in the chapter on physiography is given in this connection.

TEMPE BUTTE, SHOWING TILTED SANDSTONE AT THE RIGHT, OVERLAIN BY ANDESITE.

A. BELL BUTTE, NEAR TEMPE.

A lava butte partly buried by valley fill.

B. NORTH END OF SUPERSTITION MOUNTAINS.

A lava promontory rising above the detrital plain of Salt River Valley.

VALLEY FILL.

At Mount McDowell Salt River emerges from the narrow canyon by which it passes through the Superstition Mountains and enters the broad bottom lands known as Salt River Valley. (Mount McDowell stands at the head of what is termed the "valley" in this paper.) Some time ago it was proposed to construct a dam across the Verde River near its junction with Salt River at Mount McDowell, and a series of borings was made across the canyon to ascertain the depth to bed rock. From the records of these borings a cross section of the

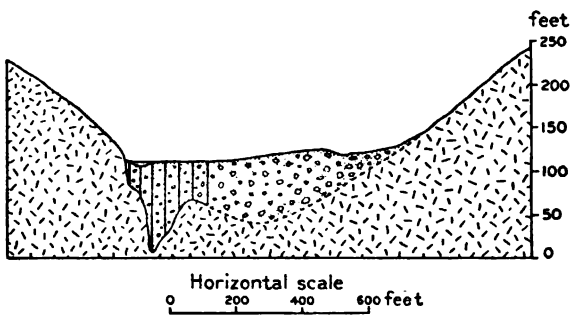


FIG. 12.—Cross section of Verde Valley near Mount McDowell, Arizona.

ancient or filled canyon of the Verde is constructed (fig. 12), showing that the valley has been filled to a depth of at least 90 feet. This valley fill is composed of waterworn material, similar to that found in the river bed and throughout the valley at the present time. This section may be taken as illustrative of the general structure of Salt River Valley. The valley, very much deeper in past ages than it is now, has been filled to its present level by fragmentary material.

STRUCTURE.

The region known as the Mesa is at the eastern extremity of the valley, lying about 25 feet higher than the bed of the river. The bluffs forming the edge of the Mesa are composed of river gravels and bowlders similar to those found in the present river bed (see Pl. IV, *A*). It is evident that the Mesa gravels were deposited by Salt River, and that because of some subsequent change in the abrasive force of the river, caused perhaps by a slight elevation of the surface, the river has cut into its former deposit to a depth of at least 25 feet near Mesa. How much deeper it cut remains unknown. The well at the creamery near Tempe, described in the former chapter, seems to be entirely in the recent material, though this can not be confidently stated. This degradation occurred over a strip 1 to 2 miles wide. The degraded area was again covered with débris forming the lowlands found along the river in the Mesa region. No deep wells have penetrated the more recent

deposits of the lowlands in the Mesa region in localities suitable to indicate the depth of these deposits. Shallow wells dug to a depth of about 50 feet seem to be wholly in the recent deposits, indicating that the erosion which formed the Mesa bluffs must have lowered the river bed at least 50 feet beneath its present elevation.

The two gravel terranes differ but slightly. Their constituents are the same, but the younger accumulations are notably less cemented. Wells sunk in them are the most productive wells in the region because of the readiness of movement of their ground waters. In the Mesa region the younger gravels are easily distinguished from the older on account of the former being confined between bluffs of the older material. But at Tempe and throughout the Phoenix region the younger gravels cover the older and their distribution can be judged only from the well records. The relations of the two series of accumulations are shown in sections AB and CD of Pl. XIX, and in the cross section near Phoenix (Pl. XXI).

MATERIAL.

The valley fill is composed of more or less irregular lenses of clay, silt, sand, gravel, wash, and bowlders. These are arranged in a most erratic manner, the character of the beds changing rapidly both vertically and horizontally, as indicated by the well records.

This material may be divided for convenience of description into (1) river débris, (2) sheet wash, and (3) chemical precipitate.

RIVER DÉBRIS.

In the present river bed are found bowlders and gravel of quartzite, quartz, chert, granite, gneiss, and various kinds of eruptive rock. The quartzose materials greatly predominate, owing, no doubt, to their enduring character. Bowlders occur with a maximum diameter of about 2 feet. A comparison of the material found in the river bed at the present time with the older material found in the exposed bluffs along the river and in the numerous wells throughout the valley indicates that for the most part the valley fill was derived from the same sources from which the present river gravels are derived, namely, the formations along the upper reaches of Salt River.

SHEET WASH.

The term wash is used in this region with at least four meanings, more or less separate and distinct:

(1) The stream courses occupied by water only in times of heavy rainfall, called arroyos in other parts of the West, are here called washes.

(2) Many of the dry stream courses having their origin in the mountains are well defined for a greater or less distance after emer-

ging from the mountains, but finally disappear on the plain, leaving no trace of a definite course. During times of flood the waters spread in a broad, thin sheet over the plain. The largest floods gradually find their way to the rivers, not by way of channels, for there are none, but by a broad wash over the even surface of the gently sloping plain. In most cases, however, the waters never reach the river, but are absorbed by the sands and gravels of the valley floor and disappear completely from the surface. The broad sheet of water thus sweeping over the surface is called a sheet wash.

(3) The material brought from the hills by the streams, many of them of considerable size—as, for example, Queen Creek and Cave Creek—is deposited as a broad fan, so broad and low, in fact, that it is scarcely separable from the general valley floor. Queen Creek has a well-defined course for about 50 miles, and Cave Creek one somewhat longer. During floods a large amount of débris is deposited along these stream courses and is locally known as wash. The material in which wells have been sunk is sometimes described as "Queen wash" or "Cave wash," etc.

(4) A fourth meaning of the term is closely allied with the third, and yet distinct enough to demand separate mention. The sudden heavy showers so characteristic of Arizona are too well known to require explanation. If a so-called cloud-burst occurs in the hills near the edge of the valley the small stream courses, flooded to overflowing, discharge their débris-charged waters upon the gentler slope of the valley floor, where all definite stream courses disappear. Should a channel by chance become established, the checked velocity of the water on the gentler slopes of the valley floor soon causes it to become choked and to be deflected and join that of the neighboring streams. The result is that flood waters from the hills move more or less in a sheet over the valley floor until they disappear beneath the surface. The loose material from the hillsides is thus brought to the valley and distributed somewhat evenly over the surface. Cloud-bursts which take place over the valley produce the sheet floods on a smaller scale. The material thus brought from the hills and distributed over the valley is called also sheet wash.

The term wash, therefore, applies (1) to a dry stream course, (2) to water moving in the form of a thin sheet over the plain, (3) to the material deposited by an intermittent stream near the base of the mountains in the form of a fan or dry delta, and (4) to the accumulations of detrital material working slowly from the hillsides, as a more or less evenly distributed sheet.

It is not difficult to understand how the washes can cause large quantities of débris to accumulate near the hills. But in the midst of the plain, miles from the hills, the sheet flood, as a geologic agent, might seem so unimportant as to be negligible. The heavy showers

occur but seldom and affect a very limited area at any one time. It is probable that scores of years may intervene between two showers sufficiently heavy to produce sheet floods at any given point, and yet the writer is of the opinion that the sheet flood is a factor which can not be neglected in the adequate explanation either of the valley fill or of the underground water contained in this fill.

As the arkose works its way down the mountain slopes and spreads over the surface of the plain, the coarse material naturally accumulates near the foot of the parent mountain, while the finer material is carried farther out. The sorting, however, is not carried on to anything like the extent observed in the case of regular streams. In many cases, indeed, the floods are so tumultuous that coarse and fine materials alike are carried forward and piled in confusion. In the less violent floods the coarse material accumulates near the hills. This fact is of the utmost importance in furnishing an explanation of certain phenomena connected with the underground waters of the valley.

The sheet wash is apt to differ from the stream-carried débris in bearing less evidence of the recognized action of running water. The water wear and sorting are at a minimum. When there is water enough to move any of the material of the wash, there is likely to be enough to move coarse and fine alike. The result is an accumulation of silt, clay, sand, and gravel commingled in every conceivable proportion. The gravels are usually angular, although some are slightly water worn. Near the granite hills the wash is composed of the coarse, angular products of the partial decomposition of the granite, previously described. When the feldspars are decomposed to such an extent that they do not easily retain their original form, the material is locally known as "talc" or "soapstone" (not to be confused with true talc and soapstone).

At Desert well the wash covering the surface is at least 180 feet thick, and no other material except a few feet of sand is found throughout that thickness. The 348-foot well of the Valley Seedless Grape Company, near the eastern end of the Salt River Mountains, is in granitic wash throughout most of its depth and at the bottom penetrates solid granite. In many places the wash from the hills gives character to the topography over wide areas. Southwest of the Superstition Mountains the surface of the desert over an area of something like 300 square miles is composed of wash from these mountains. The small stream courses from the mountains soon disappear in a regularly inclined desert surface which is practically wanting in even the smallest stream courses.

Queen Creek, which may be taken as a type of the streams that enter the valley from the neighboring mountains and disappear on the valley floor, illustrates the manner of accumulation of wash. It has a drainage area of about 143 square miles in the mountainous

district northeast of Florence, and its course is traceable in a distinct channel for a distance of over 40 miles, but on entering the valley the waters soon sink from view into the sands and gravels of the floor, leaving the bed dry except in times of flood. A few miles below the dam site at Whitlow's ranch the creek emerges from the hills upon the sloping plain of the valley, and thence to the end of its course follows no well-defined depression or valley. From Whitlow's ranch to the end of the course near Andrada well the creek bed has a fall of about 665 feet, making an average gradient of 28 feet to the mile, which above the ranch is still higher. With such a gradient it is evident that during times of flood great quantities of débris must be swept from the hills. The floods are in part checked as they enter the plain and in part lost by sinking into the gravels, and the débris is deposited, building up the course of the stream. The result is that numerous channels occur side by side, more or less connected by crosscuts forming a network of interlacing courses. A second result is that along the lower reaches of its course, Queen Creek has built up a fan or dry delta above the surface of the surrounding plain. A similar fan has been built by Cave Creek, the lower reaches of which are within the area covered by the detailed topographic map of Salt River Valley. The deflection of the contours south of Cave Creek, as shown on this map, is due to the general elevation of the land surface in that region caused by the Cave Creek fan. North of Sacaton Mountains Queen Creek branches into numerous forks or distributaries and is eventually lost in the general surface of the plain. From this point to the Gila River, a distance of about 15 miles, there is no stream channel. Floods large enough and lasting enough to reach the Gila pass over this last 15 miles as sheet washes. These washes are said to vary from a few inches to 2 feet in depth and the water is so loaded with silt and floating vegetation that it works its way slowly over the plain without excavating channels even where the slope is comparatively steep.

It is seldom, however, that floods occur of sufficient size and duration to reach the Gila, being more often lost in the valley fill long before reaching that river. The amount of water which thus sinks beneath the surface, together with the intermittent character of the flow, is well shown in the accompanying table and diagram (fig. 13) taken from the paper on Irrigation near Phoenix, Ariz., by A. P. Davis.[a]

[a] Davis, A. P., Irrigation near Phoenix, Ariz.: Water-Sup. and Irr. Paper No. 2, U. S. Geol. Survey, 1897.

Estimated monthly discharge of Queen Creek, Whitlow's ranch, Arizona, in 1896.

[Drainage area, 143 square miles.]

Month.	Discharge.			Total for month in acre-feet.
	Maximum in second-feet.	Minimum in second-feet.	Mean in second-feet.	
January	2	2.0	2.0	123
February	2	2.0	2.0	115
March	2	2.0	2.0	123
April	2	1.0	1.5	87
May	1	1.0	1.0	61
June	1	1.0	1.0	60
July	9,000	.....	121.6	7,480
August	1,433	.6	13.1	805
September	3,428	.5	17.1	1,016
October	1,188	.5	13.3	820
November	80	.6	1.3	80
December	207	.6	2.0	120
Total	9,000	.....	15.0	10,890

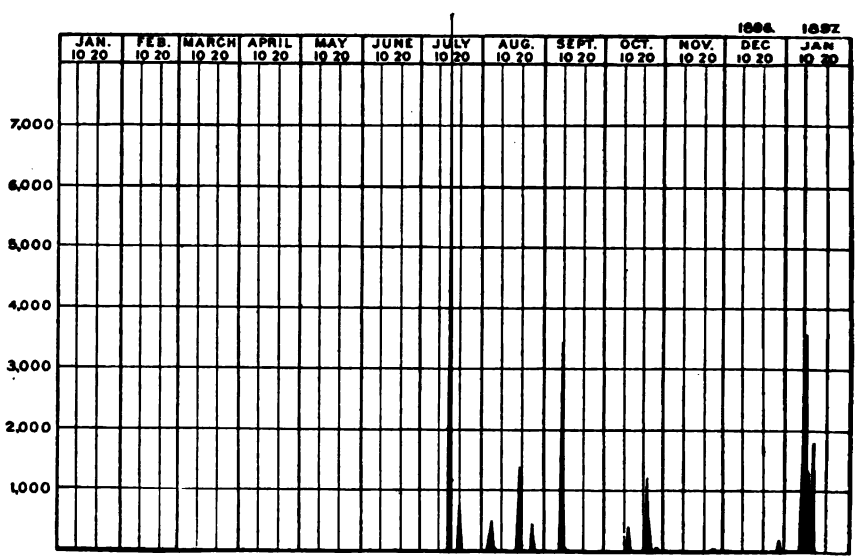


FIG. 13.—Daily discharge of Queen Creek.

Robert Bowen, who owns a ranch about 6 miles east of Harrington well, on Queen Creek, pointed out to me certain fields which were flooded a few months previous to my visit. There are 6 channels at this point, varying from a few feet to about 100 feet in width. In order to flood the fields in question the water in these channels must

have had a depth of at least 5 feet. Mr. Bowen states that at the Harrington ranch, 6 miles downstream, there was not enough water to fill certain irrigation ditches which had been prepared for the diversion of flood waters. Here then is a specific case of a flood of somewhat notable volume that sank into the sands and gravels of the valley fill within a distance of about 6 miles.

CHEMICAL PRECIPITATES.

Caliche.—In nearly every well of the valley a substance is encountered, in greater or less quantity, which is commonly known as cement or hardpan. This material is also known, though less generally, as caliche, and has been described by Prof. W. P. Blake,[a] of the University of Arizona, who says:

In southern Arizona and in Mexico the word caliche is in general use to denote a calcareous formation of considerable thickness and volume found a few inches, or a few feet, beneath the surface soil, upon the broad, dry, gravelly plains and mesas. * * *

Caliche has a wide distribution in the regions of Arizona and Mexico. It is usually hidden from view by a slight covering of soil, but it is easily found by digging, and is often revealed by a flow of water during heavy rains. It is practically a continuous sheet, from 3 to 15 feet thick, of earthy limestone or travertine, through which the smaller plant roots find their way with difficulty. * * *

The top of the caliche is more dense and solid than the lower portions. The surface of this crust, or layer, is comparatively smooth, though undulating, while the lower portions, under the crust, are irregular, cavernous, earthy, and very porous, blending gradually with the materials of the sandy and gravelly beds, from which they are divided by no sharply defined plane of stratification or separation. The caliche invests, surrounds, and includes sand grains, gravels, and more or less earthy material, but seems to have had the power, especially in its upper crust, of extruding the coarse materials of the soil to a great extent.

The deposit does not form a regular horizontal bed conformable with the rude stratification of the gravels and sands, but conforms roughly with the general surface, rising and falling with the undulations of the mesa. There are, in places, repetitions of the compact layers, separated by a few inches of the amorphous and more earthy deposit. * * *

Close observation detects, in some places, small perforations, like pin holes, at the top, which enlarge gradually below and penetrate the entire compact crust, becoming lost in the irregular amorphous granular mass. * * *

The caliche is an example of deposition independent of the influence of organic agencies. * * *

In chemical composition the caliche is essentially a lime carbonate, but contains some calcium, magnesium, and aluminum silicates, as more fully shown by the result of an analysis made by my assistant, Mr. J. S. Mann, in the laboratory of the Arizona School of Mines:

[a] Blake, William P., The caliche of southern Arizona: Trans. Am. Inst. Min. Eng., vol. 31, 1901, p. 220.

Analysis of Arizona caliche.

Calcium carbonate ($CaCO_3$)	72.28
Magnesium carbonate ($MgCO_3$)	2.13
Calcium silicate ($CaSiO_3$)	5.57
Aluminum silicate ($AlSiO_5$)	7.37
Ferric oxide (Fe_2O_3)	1.88
Moisture (H_2O)	1.20
Total	96.43

This caliche, unlike the deposits of travertine formed in the open air, is not sufficiently compact and solid to be useful in construction, as was the travertine of ancient Rome. When calcined it yields good caustic lime, which, tempered with sand, makes a strong, quick-setting mortar or cement. It is quarried and used for this purpose in some places. Occurring as it does in mixture with gravel and sand, it has the appearance of an artificial mixture. * * *

After describing local conditions and giving the analyses of water from 7 wells near Tucson, which indicate that the underground waters contain the principal elements found in caliche, Professor Blake adds:

There has been much speculation in regard to the origin of the caliche. It has been generally assumed to be a deposition from some ancient lake, or body of water, once covering the area in which it is found. But such a theory is untenable when all the phenomena are considered. The formation is clearly the result of the upward capillary flow of calcareous water, induced by constant and rapid evaporation at the surface in a comparatively rainless region.

With a constant supply of phreatic calcareous water, the second great essential factor in the formation of caliche is the continued desiccating atmosphere—a condition which prevails, with only short and temporary exceptions, through the year. The desert and semidesert regions of Arizona are characterized meteorologically by the unusual dryness of the air and its capacity for the absorption of moisture and by the maintenance of continued evaporation from the soil, which determines a constant upward movement of the phreatic water. The occasional rains in midsummer and midwinter do not penetrate to great depths, but are sufficient to leach out the soil to the depth of a few inches or feet, turning the calcareous solution back and downward and producing the denser upper crust, where it meets the upward flow.

Such I conceive to be the origin of the caliche. It may be called a subterranean deposit of travertine; but it is not the result of a flow from springs or from any source at the surface, or from the lateral movement of water. Unlike ordinary travertine, it is the result not of descending but of ascending currents. The ordinary conditions of vadose circulation are reversed. The caliche is a fine example of the formation of extensive calcareous strata in the midst of preexistent beds, not by metasomatic processes, but by precipitaton from sources below.

To Professor Blake's description I would add that caliche occurs in varying degrees of purity and that any consolidated layer is locally known as cement. When caliche is not mixed with a considerable amount of foreign material it may become very compact, resembling a fine-grained limestone, and sometimes causes much difficulty in sinking wells through it. Several cases are on record where wells were abandoned because the casing caught on a cement layer and could be forced no farther.

A sand or gravel bed cemented with this material often becomes impervious to water. The confining strata above the water in nearly all the wells of Salt River Valley, where water is found under pressure, contain more or less caliche in the form of a cementing material.

It will be noted that according to Professor Blake's interpretation the caliche is due to the deposition of compounds gathered from some outside source and brought in solution, through underground passages, to the region where they are deposited through the agency of surface evaporation. Applying this explanation to the origin of the caliche layers in the valley fill of Salt River Valley, it is evident from the analyses of waters already given and from the rocks previously described, which furnish by their decomposition the elements brought into the valley by the waters, that all elements necessary for the formation of caliche are present. The prevalence of caliche at or near the surface strengthens the postulate that the surface is its natural place of formation. Since the valley fill, as explained elsewhere, is due to the gradual filling of the valley by débris shed from the hills, each horizon throughout its depth has at some former time been the surface. Hence the presence of caliche bands at all horizons.

It should be noted, however, that bicarbonates are present in nearly all the waters of the valley. A relief of pressure alone is sufficient under certain conditions for the escape of carbon dioxide, which causes the bicarbonates to change to the comparatively insoluble carbonates, which are then readily deposited. It is entirely possible, therefore, that the deposition of caliche may take place at some depth beneath the surface, in fact at any depth where the pressure upon water containing bicarbonates in solution is sufficiently relieved and opportunity given for the escape of the gas.

The postulate that caliche is in some cases at least deposited without the influence of surface evaporation, is strengthened by the observation of uneven porous structures on the under side of caliche layers. This strongly suggests the deposition of caliche beneath, after the impervious layer had been formed. A lowering of the water table during dry cycles, such as are known to occur, would naturally leave beneath a caliche layer which had been formed near the surface a space occupied by loose gravels, no longer filled with water as before. The caliche layer would prevent any great amount of evaporation, but probably would not prevent relief of pressure upon the water in the gravels beneath. A relief of pressure might cause a loss of carbon dioxide and result in deposition of the insoluble carbonates.

A case in hand is found at the Murphy-McQueen pumping plant (see p. 12). Beneath the 13 feet of soil at the surface coarse gravels and bowlders occur to a depth of 34 feet. The material in the upper 13 feet is free from any notable amount of caliche, while the loose

gravels and bowlders are more or less cemented. The bowlders are encased somewhat uniformly in a white crust of caliche, often thick enough to unite them into resistant masses; the cementing is irregular, however, uncemented portions being found throughout the mass. Accepting the postulate of surface formation of caliche through the agency of evaporation, the soil above should be cemented. This is not the case. On the other hand, accepting the postulate of deposition of this caliche at some former time when the bowlders were at the surface, it is inconceivable that the caliche should be as irregularly distributed as it is. It is known that there has been a lowering of 12 feet in the underground water at this place in the last four years. There is every reason for believing that at some time the underground waters filled the gravels up to the bottom of the soil layer, and that a subsequent fall of these waters from the soil layer left a bed of loose gravel above the surface of the underground waters where these waters were not only under no pressure but were lifted to some extent among the loose gravels by capillary action, where they would naturally deposit their contained minerals on the surface of the gravels. Cyclic oscillations of the underground water would distribute this action through a considerable depth.

On the other hand, caliche is present on the hillsides far above the reach of any permanent supply of underground water. It is found generally along the slopes of the hills and over dry plains such as that in the vicinity of Desert well, where no underground water is found within hundreds of feet of the surface. (Water is found at a depth of 212 feet at Desert well and 284 feet in the Kleinman well.) Caliche found at the surface of this dry plain and on the barren hillsides can scarcely be due to the evaporation of water which can in any sense be called an underground supply as postulated by Professor Blake.

A somewhat different view is held by Prof. R. H. Forbes, director and chemist of the agricultural experiment station of Arizona, who has given the subject considerable study from a chemical standpoint. At the writer's request he has furnished the following statement of his opinion:

My view of the formation of caliche is that in this region of scanty rainfall, which penetrates the ground from a few inches to a maximum of a very few feet—say 3 or 4—the rain water, containing a small amount of carbon dioxide, percolating from the surface to this maximum depth of, say, 3 feet, dissolves small portions of calcium and magnesium bicarbonates in the form of normal carbonates, leaving in course of time a layer of limy hardpan at the depths to which it penetrates. The large amount of siliceous material found in caliche layers indicates also that colloidal clayey materials are carried down mechanically by percolating rainfall, the result being the mixture of siliceous calcareous materials, together with portions of original soil in situ, which are found to constitute nearly all of our caliche layers. The different layers found at different depths below the surface mark the various levels which for geologic reasons remained constant for a long enough period of time to permit the formation of a layer of caliche just below the surface of that time. I have noticed also that

igneous rocks at the base of hills containing calcareous materials are often coated with a thin layer of calcareous materials, evidently carried in solution in carbonated waters from higher levels and deposited upon these rocks, over which this drainage percolated, through the agency of evaporation, aeration, or heat.

It should be noted that while the two hypotheses attribute the origin of caliche to the deposit by evaporation of salts held in solution, they differ in this: Blake's postulate assumes a more or less definite underground flow bringing the materials from a distance, while Forbes's postulate assumes that the materials are taken into solution at the surface through the agency of carbonated rain water, held in solution but a short time near the surface, and deposited by evaporation at no great distance from the place of their origin. Each postulate seems satisfactory in certain cases and unsatisfactory in other cases. It seems probable that many of the caliche layers of Salt River Valley have been formed from the carbonates and other salts held in solution in the underground flow, as postulated by Blake. It seems equally evident that the caliche of the hillsides and the dry plains has been formed in some such manner as that described by Forbes.

There are still other cases where deposition of caliche evidently takes place in subterranean cavities where evaporation can have little influence, either because of relief of pressure, as previously suggested, or from some other cause not yet recognized.

Salts.—In addition to the caliche considerable quantities of the various salts found in solution in all of the waters of the valley have been deposited in the valley fill. While they are quantitatively unimportant from a geologic standpoint, they are of the greatest importance in influencing the character of the water. The principal salts are sodium chloride (common salt), calcium and magnesium sulphates (hardness), and calcium carbonate (lime). The salts are irregularly diffused through the materials composing the valley fill, and their amount, kind, distribution, etc., will be described more in detail in connection with the chemical character of the waters.

AGE OF THE VALLEY FILL.

The physiographic relations of the valley fill indicate that it is comparatively young, but no fossil forms have been found in any of the deposits. As already indicated, there are at least two periods of accumulation represented at the surface. During the accumulation of over 1,300 feet of the detrital material it is possible that there were more than two such periods. Good exposures are wanting in Salt River Valley, but similar deposits are widely distributed over western Arizona, and a comparison with regions where the recent deposits are better exposed seems to throw light on the question of age. A similarity in the succession of events recorded indicates that certain sur-

face movements have been somewhat general over a large portion of western Arizona.

The Colorado River probably furnishes the best index available to the general surface movements of the Southwest. In an examination of northwestern Arizona, described elsewhere, the author noted at numerous points a series of tilted and partly consolidated conglomerates and breccias, overlain by more recent and unconsolidated sands and gravels, which were in turn dissected and overlain by a third series now accumulating to form the present lowlands along the Colorado River. The older series is extensive both in thickness and areal distribution. Its original thickness must have been at least 2,500 feet, remnants being now found 2,300 feet above the river, and it extends downward to some unknown depth beneath its bed. The next younger deposits are less extensive, and the youngest form the present flood plain.

The succession of events recorded in these deposits as well as in those of Salt River Valley and elsewhere is indicated in fig. 14. The original valley (A) was filled with the oldest débris (B), and this in turn was eroded (C) and again filled with the second accumulation (D). A third stage of erosion excavated the present valley (E), and the deposits now accumulating are represented in stage F.

A similar succession of events has been noted at several points in Arizona, notably along San Pedro, Santa Cruz, and upper Gila rivers, and in Tonto basin, as well as in a number of places in northwestern Arizona. Near Benson, in San Pedro Valley, wells have penetrated the valley fill to a depth of about 800 feet without reaching bed rock.

In the Tonto basin upland deposits of at least two periods of accumulation are exposed. The older is a coarse breccia, moderately well consolidated and more or less tilted in places (Pl. XIV, *B*). This breccia rests upon the eroded surface of the older formations and is deeply dissected in places. Against this tilted breccia rest nearly horizontal beds of more recent sediments, which are in turn dissected, large portions of them having been carried away by the more recent action of the river (Pl. XIV, *A*). Nothing was found to indicate the geologic age of either deposit, but the older is regarded as probably representing the base of the Quaternary.[a]

There have been, then, since the original formation of Tonto basin at least 5 separate stages: (1) The period of erosion, which, in part at least, formed the basin, corresponding with stage A of fig. 14; (2) a period of accumulation, during which the breccia just described was deposited, this period corresponding to stage B; (3) a period of

[a] Gilbert, G. K., Report on the geology of portions of New Mexico and Arizona: U. S. Geog. Surv. W. 100th Mer., vol. 3, 1875, p. 540.

Ransome, F. L., Geology of the Globe copper district, Arizona: Prof. Paper U. S. Geol. Survey No. 12, 1903, p. 57.

A. CLAY BANK IN TONTO BASIN, FROM WHICH CLAY WILL BE OBTAINED FOR CEMENT IN THE CONSTRUCTION OF SALT RIVER DAM.

B. TILTED BRECCIA IN TONTO BASIN.

Accumulation represented by stage B.

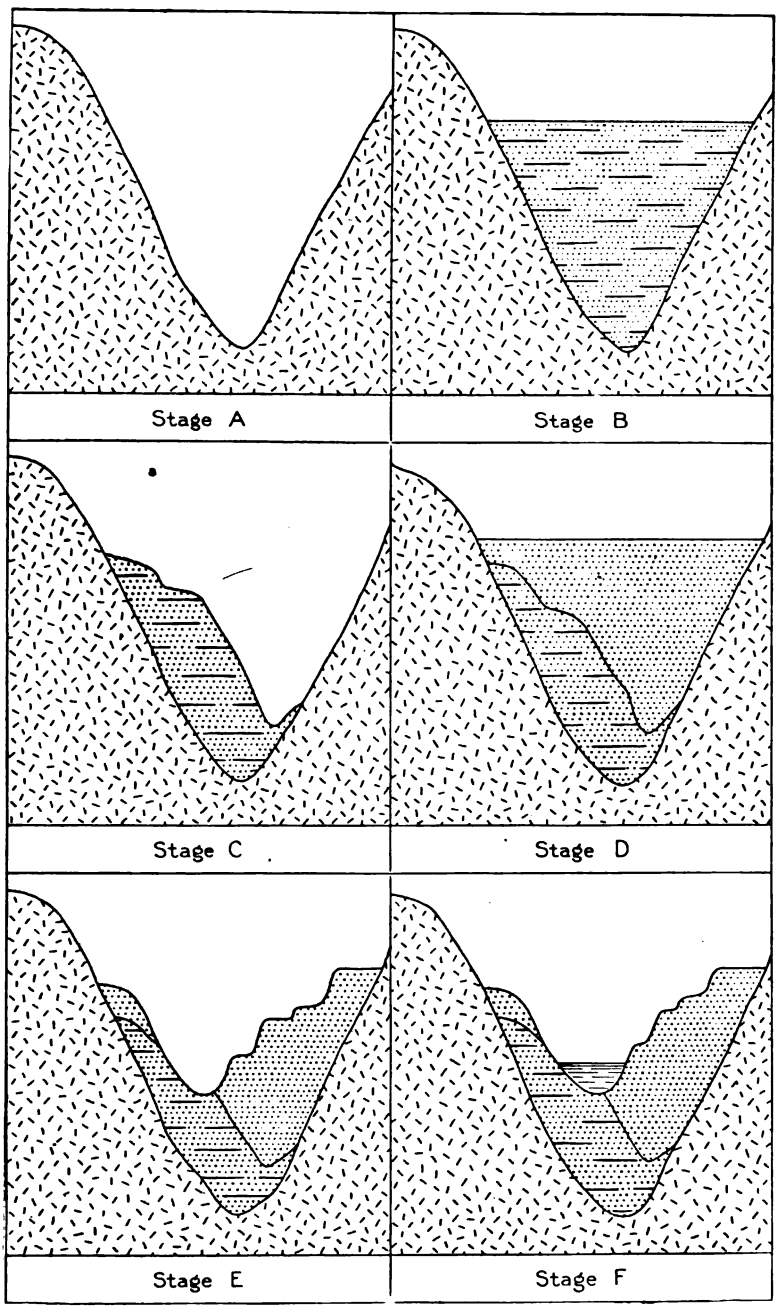


FIG. 14.—Diagrammatic illustration of valley filling and erosion in central and western Arizona.

erosion, probably inaugurated by uplift and tilting, in which the breccia was dissected, this period corresponding to stage C; (4) a period of accumulation, in which the younger sediments of the basin were deposited on or against the dissected breccia—stage D; (5) a period of erosion, the present stage of the river, during which the present valley has been excavated—stage E.

Since the same succession of events is shown to the west of Salt River Valley along the Colorado, to the east in Tonto basin, to the southeast in San Pedro Valley, etc., it is possible that the various stages are due to far-reaching causes affecting Salt River Valley in common with the other localities named.

The older mesa gravels of Salt River Valley may represent stage B, while the younger gravels represent stage D and the present river channel, stage E. There are no accumulations in Salt River Valley, except the gravels of the broad bed of the river, which can be compared to the accumulation of stage F. The similar succession of events in widely separated localities is suggestive of common causes, but no definite correlation is possible at the present time. This much, however, can be stated with reasonable confidence—the valley fill is not the result of continuous aggradation. Periods of erosion have alternated with periods of accumulation.

It is worthy of note that in the three deepest wells of the valley—the Murphy-McQueen well, 1,305 feet; the Chandler well, 705 feet; and the Thomas Murphy well, 865 feet—a considerable thickness of clay or other fine material occurs beneath the coarse detritus. In the Murphy-McQueen well this material is described as "chalk rock" and "talc." The writer has seen a small portion of the material taken from the 1,305-foot level. It consisted of clay containing a few quartz pebbles. The clay from the bottom of the Thomas Murphy well is very plastic and contains no fragments of foreign material. The clay apparently lies underneath the breccia. Little more is known of the lower horizons of the valley fill. The material of the upper horizons, so far as known, is evidently due to upland accumulation. For this reason, and because of the want of definite information concerning the lower horizons, the whole thickness of the valley fill has been assumed to originate in the same way. What little is known of the lower horizons suggests the possibility of lacustrine origin. The occurrence of the clay underneath the breccia near Phoenix suggests that the clay beds encountered in the Mesa region may be notably older than the detrital material above. In that case the lower part of the valley fill may be of Tertiary age, and a thickness of only a few hundred feet at the top may belong to the Quaternary.

SURFACE MOVEMENTS.

There is abundant evidence that changes in surface elevation have taken place in and about Salt River Valley in comparatively recent times.

(1) The immense deposits of upland accumulation in this region are best explained as due to subsidence of the surface. The general occurrence of upland accumulations of débris throughout western Arizona and southern California suggests that the same cause affected wide areas. It is probable that these accumulations are in part due to desiccation of the climate. There is abundant evidence that in former ages streams of considerable size occupied valleys which are now dry. However much desiccation of the climate may have caused a diminution of streams and consequent deposition of débris in valleys which were formerly swept clear by these streams, it can not wholly account for this accumulation.

The present surface elevation at Mesa is about 1,200 feet. The deep well at Mesa—1,305 feet—extends about 100 feet below sea level and does not reach bed rock. It is obvious that at this point the surface must have been at a greater elevation when the valley was formed, since the river could not excavate the valley below sea level. Similar thicknesses of the upland débris occur elsewhere—800 feet in San Pedro Valley; 1,000 feet in Sacramento Valley at Yucca, Ariz., and about 2,400 feet exposed in the bluffs of the Colorado River. In none of these places, however, is bed rock reached. The evidence points to a general subsidence as the initial cause of the upland deposits.

(2) Local movements. The sandstones and the breccia near Tempe and at Mount McDowell, near the head of the valley, are highly inclined. The attitude of the sediments in Tonto basin indicates faulting and tilting to a notable extent, and Ransome[a] describes an area of intense faulting and movement east of Salt River Valley. Faulting and block tilting are not easily recognized in crystalline formations such as those immediately surrounding the valley, and the covering of detrital matter renders the location of possible fault lines doubtful. Reasoning, however, from analogy it is probable that faulting and block tilting have played a considerable part in bringing about present relations in and near Salt River Valley.

The most conspicuous example of a tilted block within the valley is found in Tempe Butte, where the sandstone and its overlying sheet of andesite are tilted steeply to the south. The movement which brought this butte to its present position was very recent. Waterworn bowl-

[a] Ransome, F. L., Geology of the Globe copper district, Arizona: Prof. Paper U. S. Geol. Survey No. 12, 1903.

ders, such as compose a large part of the valley fill, are found on the sides of the butte above the level of the valley floor, and although they

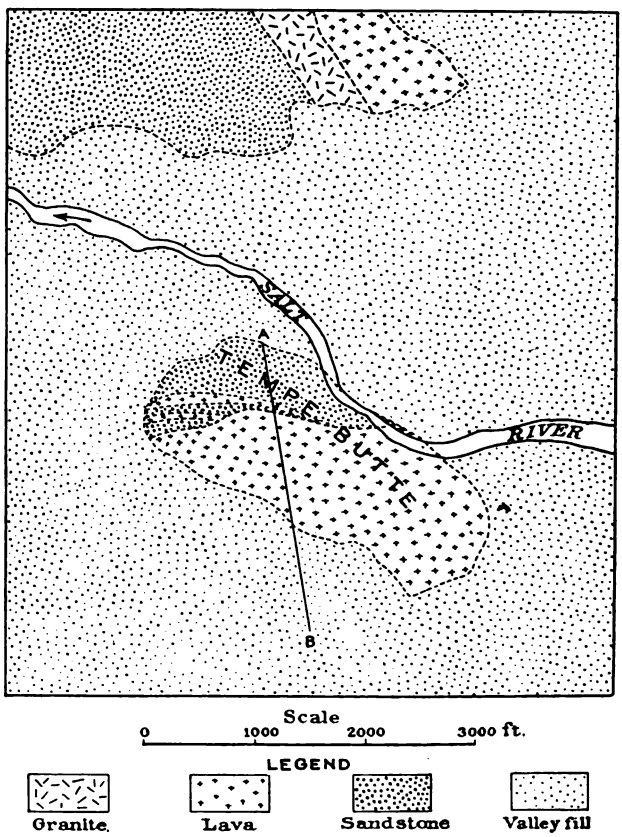


FIG. 15.—Geologic map of Tempe Butte.

lie loose on the steep sides, sufficient time has not elapsed since their elevation to allow of their finding their way back to the river which

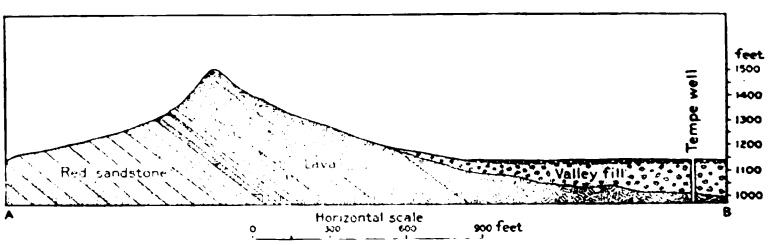


FIG. 16.—Section through Tempe Butte and Tempe well.

flows at the foot of the butte. The attitude of the formations and their relations to each other are indicated in figs. 15 and 16.

CHAPTER III.

PHYSIOGRAPHY.

MOUNTAIN AND PLAIN.

The so-called valleys of Salt and Gila rivers are but parts of a broad plain occupying a large portion of southwestern Arizona. The valleys are in part surrounded by mountainous areas, and they themselves in turn surround isolated peaks and groups of mountains which rise abruptly from their surface. To the north and east the country becomes more and more mountainous to the edge of the high plateau, which within a distance of something like 80 miles rises to an elevation of about 7,500 feet, as indicated in the sketch profile fig. 17. The escarpment bordering the great western plateau passes through this region. The surface of the plateau slopes northward, while the drainage from its face—the edge of the Mogollon Mesa—together with that from the broken country to the southwest of the escarpment forms Salt and Verde rivers, thus furnishing the water which supplies Salt River Valley. In a general way the aggraded

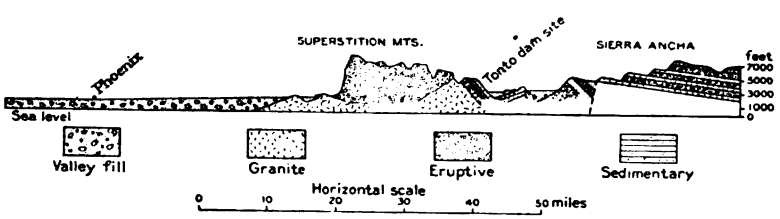


Fig. 17.—Sketch profile from the Agua Fria, through Tonto basin and the Sierra Ancha.

plain of which Salt River Valley is a part lies at the foot of the escarpment bordering the plateau, and has been filled and graded principally by material shed from the edge of this plateau. Between the escarpment proper and the aggraded plain there is much broken country of which little is known. Toward the south and west of the escarpment the mountain masses stand out as more or less isolated groups, separated by stretches of fairly level plains, as, for example, the Salt River and Sacaton mountains.

The plain from which these comparatively small mountain groups rise has a regular and moderately uniform slope corresponding to the gradients of the streams. In some cases the transition from mountain to plain is marked by a series of partly buried hills, which were

originally outlying remnants of erosion and which have since been surrounded by débris shed from the mountain slope. This is illustrated in a small way south of the Phoenix Mountains (Pl. XV). In a larger way the groups of mountains, such as Salt River Mountains, Sacaton Mountains, etc., are also remnants of erosion partly buried by débris. In other cases the mountains rise from the graded plain or valley floor with the utmost abruptness, as in the case of Bell Butte (Pl. XIII, *A*), and Camelback Mountain (Pl. XVI, *A*). Probably the most notable physiographic feature of the region is the abrupt transition from mountain to plain.

In the views, previously referred to, of Tempe Butte, Bell Butte, etc., the aggraded plain shown in the foreground extends to the abrupt rocky slopes with little or no transition. Irrigable lands extend to the foot of the slopes, as indicated in Pl. XVII, which is a view from the top of Tempe Butte. The explanation of these relations is found in the study of the material and structure of the valley floor. The old valley has been flooded with débris and the outlying peaks and spurs partly or wholly submerged.

THE MESA REGION.

The Mesa gravels, or older gravel accumulations, were deposited to an elevation 25 feet or more above the present river bed. Later these gravels were cut by the river to a depth of at least 75 feet, and this

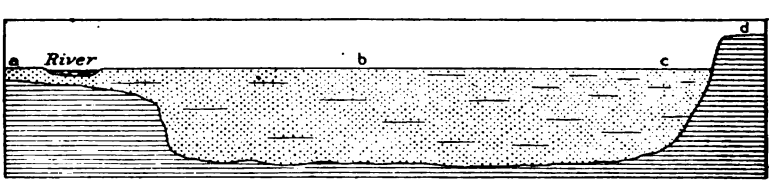
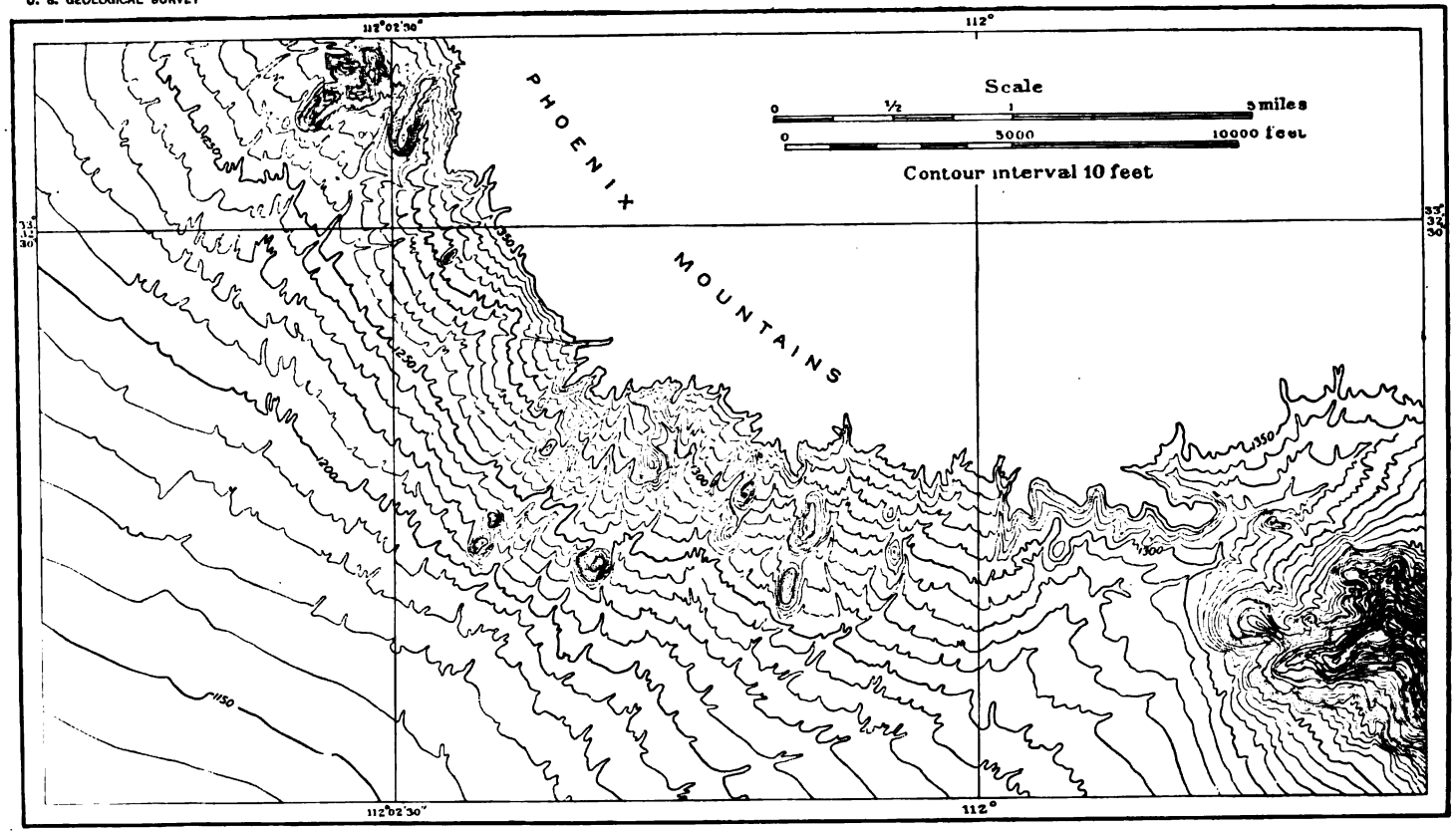


FIG. 18.—Sketch section illustrating the restricted area of water-bearing gravels due to underground structure. The older accumulation (stage B) was dissected (stage C) and the valley filled (stage D).

depression widened several miles. Later still this degraded area was partly filled. There is, then, an old valley filled with débris in which a younger valley was excavated, to be, in turn, itself filled with débris. It may be best explained, in this connection, why certain wells are productive while others in seemingly as good positions fail. If the old valley fill—the Mesa gravels—had become impervious by the deposit of silt or caliche, or from any other cause, and the present river gravels had remained unconsolidated, a water-bearing stratum of restricted distribution would occur, corresponding in extent to the recent gravels. If the recent gravels had filled the secondary valley and spread over the older accumulations, wells sunk in the strip covered by the recent gravels would be productive while wells outside of this strip would be unproductive. This is illustrated graphically in fig. 18.



MAP OF BASE OF PHOENIX MOUNTAINS, SHOWING SMALL OUTLYING POINTS PARTLY SUBMERGED IN DÉBRIS.

A. CAMELBACK MOUNTAIN FROM NEAR POWER HOUSE ON ARIZONA CANAL. RISING ABRUPTLY FROM DETRITAL PLAIN.

B. SEEPAGE LAND NEAR TEMPE.

VIEW EASTWARD FROM TEMPE BUTTE.

The valley thus filled with débris may or may not correspond with the present course of the river. Changes in the river's course over an aggrading area are the rule rather than the exception. Old channels, therefore, which do not correspond with the present river's course are to be expected in the valley fill, and incidentally these old channels are likely to give the most productive wells. The old débris-filled channels may be narrow like the present channel of Salt River near the upper end of the valley, or may be miles in width according to circumstances.

In the accompanying sketch (fig. 18) the lined area represents the older gravels and the dotted area the younger. If both be pervious, wells will yield water whether put down in the ancient or the recent gravels. If, on the other hand, the older gravels be consolidated by the deposition of caliche or otherwise and thus made impervious to water, a well at *c* would yield water while a well at *d* would yield none. At *a* the well would strike water near the surface but would soon enter nonproductive material. Examples similar to these are familiar in the construction of wells throughout the valley.

WATER TABLE.

Mesa Township was selected as being the most favorable, all things considered, for testing the regularity of the water table and its relation to the land surface. Every well was measured and the data were tabulated and placed on the map. From these data the water table of Mesa Township has been constructed in contour, and appears on the map (Pl. XVIII).

Several special features are to be noted in connection with the water table. As indicated by the sections the line representing the water table and passing through the town at right angles to the river (CC) is horizontal and at the level of the water in the river. The lines representing the water table drawn parallel to the river (AA and BB) indicate a uniform slope downstream, but the gradient of the water table is lower than the gradient of the river, and the water table approaches the surface downstream as far as Tempe, where a break occurs which is described later. On the other hand going upstream the water table becomes progressively farther beneath the surface.

From this township as a center the investigation was pushed in every direction and from the data furnished by well records given in part in Chapter I the water table has been constructed in contour for the greater part of Salt River Valley (Pl. XX).

By an inspection of the tables and of the maps constructed from these tables it is seen that the surface of the underground water is a comparatively regular plain, sloping in general with the grade of the

river, the rate of fall averaging about 10 feet per mile. The cross sections of Mesa Township (Pl. XVIII), where the wells are numerous, indicate that a line projected across the water surfaces in the wells in any direction is practically a straight line, and furthermore that the water level in any well is practically the level of the river bed at the point nearest that well. This is modified in certain cases near the river, which are described later. So regular is the surface of the underground water that the depth to water at any point of known elevation can usually be foreseen with considerable accuracy.

The water table as here described is not necessarily the same as the water-bearing stratum. For example, the water table at some particular point may be 30 feet beneath the surface. Water may or may not be found at that depth, but if found at a depth of 40 feet it will rise 10 feet in the well, and if found at 100 feet it will rise 70 feet in the well.

The shallow wells have an annual and a cyclic variation. During the dry summer season the water lowers more or less, and the shallower wells become dry. During seasons of more abundant rainfall the water level rises again. There are several facts connected with this annual variation which are worthy of note:

(1) The stage of lowest water is not coincident with the driest season, but is reached some time after the rains begin.

(2) The water in the wells seems to stand at its maximum height far into the dry season.

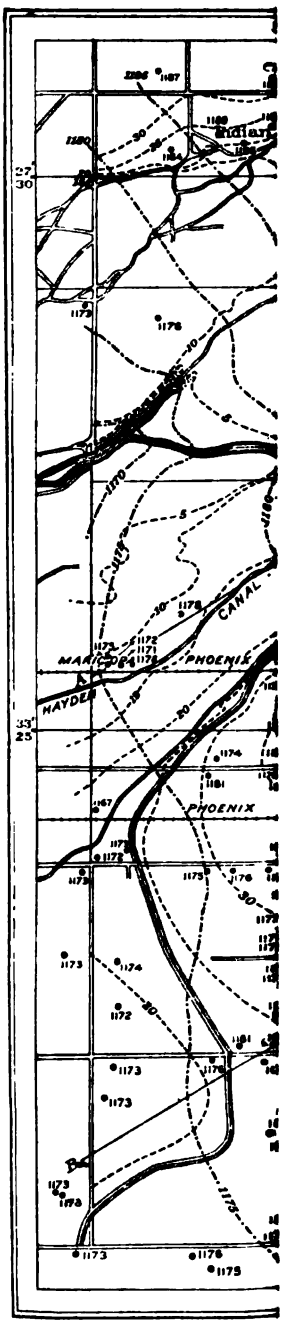
(3) The variations in water level can not be due to rainfall in the valley for the obvious reason that not enough rain falls to supply the quantity of water represented by the variations, even if it all joined the underground water.

As a matter of fact very little of the water falling as rain in the valley can enter the wells, except in certain localities where wells are obviously fed by surface water. The impervious layers of caliche common throughout the valley would prevent a great amount of surface water from joining the underflow, even if evaporation allowed an appreciable amount to remain permanently in the soil.

The only supply of water that is quantitatively adequate to explain the phenomena is that from the river and from the flood waters entering the valley from the surrounding hills. Waters move through sand and gravel very slowly, and a greater or less time, differing according to circumstances, must elapse after the floods enter the valley before their influence can be felt in the wells. Theoretically, there should be a retardation, or lagging of effect, and such is found to be the case in the variations of the water level.

The cyclic variations may be explained in the same way, but less accurate knowledge is obtainable than in the case of the annual variations. During the past few years the shallow wells throughout the valley have been lowered repeatedly. South of Tempe, where the

U. S. GEOLOGICAL SURVEY



MAP 8

water level is said to have been formerly within 2 feet of the surface, it is now 8 feet. At Mesa it has lowered 12 feet in four years; at the Phoenix Indian School it has lowered 20 feet in ten years. This is commonly attributed to the drought which has prevailed during the past few years. It may be partly due also to the increasing number of wells in use. The quantity of ground water is not unlimited and the operation of a large number of pumps must in time affect the supply.

The deep wells which draw their water from the lower water horizons vary to some extent, but little is yet known of them. The water level in Mr. Olsen's well rose 2 feet in less than three months, February 1 to April 14, 1903. The water in Desert well has been rising for the past eight years—during the time when the shallower wells of the valley were being repeatedly lowered to obtain water. The deeper water-bearing beds naturally draw their supply from points farther out toward the borders of the valley and the waters may have a greater distance to travel through the valley fill than those of the surface flow. It is possible also that the zigzag course which the water may follow in the valley fill is a matter of much importance. If the ideal section given in fig. 3 represents actual conditions, water from the river would pass laterally six times partly across the valley before reaching the lowest gravels. At the rate of flow as described later on it might take many years for water to make such a journey. The waters of any particular flood may not reach the deep wells until several years after the flood occurs.

It is likely, however, that the water level in a particular well would be affected by a flood long before the waters of that flood actually arrived at the well. Much as a wave may travel faster than the water composing the wave, so there may be waves or pulsations in the underflow due to the entrance of flood waters. The smaller pulsations—the annual ones—might and probably do appear in the shallow wells. These smaller pulsations may become imperceptible where they travel far, and may merge into cyclic pulsations, which alone affect wells far from the source of supply—for example, the Desert well.

On account of these variations of the water table certain allowances must be made in applying the accompanying maps which indicate by contours the elevation of the water table and the depth of this table beneath the surface. At a certain point, for example, the depth to water was 20 feet when the map was constructed. At some future time the depth may be greater or less than 20 feet according as the volume of underground water may have increased or diminished.

THE RIVER AND THE UNDERFLOW.

The river is considered the most important source of the underflow. There is a permanent water supply in it from the head of the valley to

the Tempe canal, north of Mesa. Below the head-gates of the Tempe canal a short space occurs in which the river is practically dry for the greater part of the year. Farther downstream underground water returns to the river bed; that is, the river cuts beneath the water table and the underflow returns in part, making a surface flow of something like 35 second-feet. It is evident, therefore, that from the head of the valley to the Tempe canal the surface flow of the river is at a higher level than the general surface of the underground water on either side. Wells sunk near the river indicate that the depression

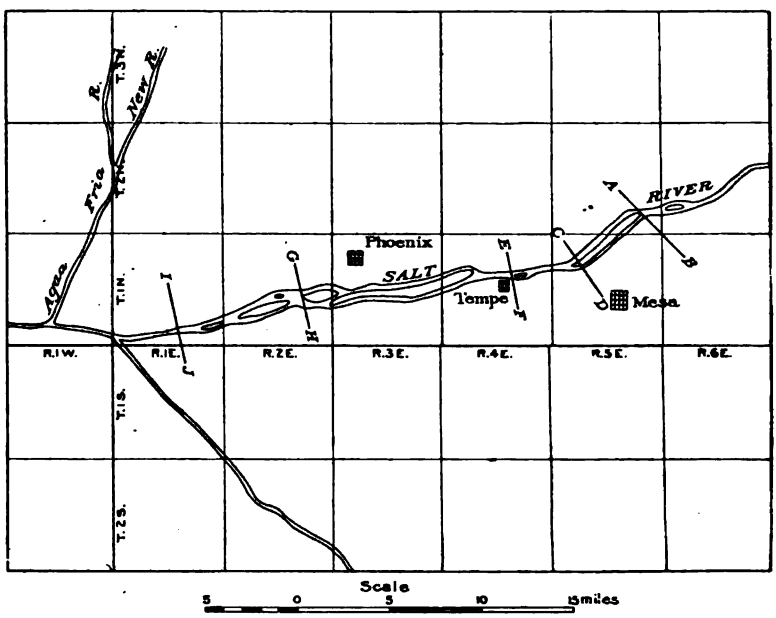
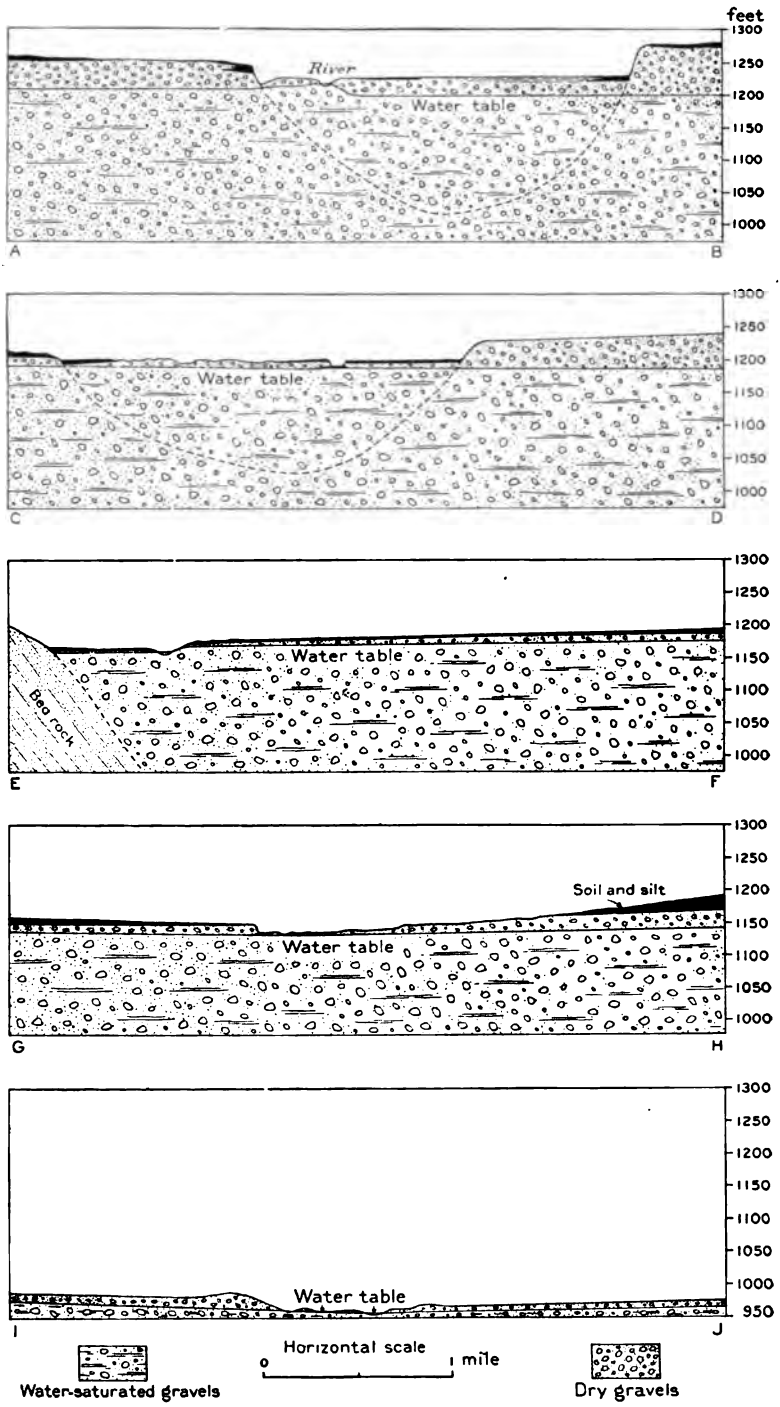


FIG. 19.—Index map of Salt River Valley, locating the sections shown in Pl. XIX.

of the water table from the river laterally is very abrupt. This is indicated by the contours of the water table as given on the map, Pl. XX, and in the sections of Pl. XIX. The fact that a permanent flow of water exists in the river at the upper end of the valley at an elevation higher than the surface of the underground water of the valley in general is of prime importance in understanding how the water enters the valley fill.

North of Mesa the river bed is at the same elevation as the water table, while at Tempe the river bed is below the water table. This explains the return of the underflow to the surface, making a perennial stream at Tempe, while the river bed both east and west of Tempe is dry. The reason for the approach of the water table to the surface near Tempe requires further explanation.



SECTIONS INDICATING RELATION OF WATER TABLE TO RIVER AND LAND SURFACES.

COURSES OF THE UNDERFLOW.

At Tempe the river flows practically on bed rock. The andesite and the red sandstones of the butte are exposed down to the water's edge. The river passes through a narrow channel between Tempe Butte and the conglomerate hills to the north. From Tempe northward to the Phoenix Mountains bed rock appears at the surface for the greater part of the distance. Where it is not exposed it is encountered in wells at no great depth. A glance at the contours of the water table of the township north of Tempe (T. 2 N., R. 4 E.) will reveal the fact that this table is 90 feet higher east of the buttes than it is about 2 miles farther west. There is then no free passage for the underflow north of Tempe except through the gravels in the immediate channel of the river.

Southwest of Tempe, Bell Butte rises from the level valley floor about midway between Tempe Butte and the Salt River Mountains. No deep wells have been drilled between Tempe and Bell Butte to indicate the underground conditions, the nearest being that of H. L. Chandler, one mile south of Tempe. This well indicates that loose gravels and bowlders extend to a depth of at least 186 feet. This would seem to indicate a free passage for the underflow between Tempe and Bell buttes. On the other hand, there is a sharp decline of the water table to the west in this region. North of Bell Butte a depression of the water table of 16 feet within half a mile was observed. South of Bell Butte a still sharper decline occurs, depressing the water table 10 feet in less than a quarter of a mile. The line along which this depression of the water table takes place is one passing from Tempe Butte through Bell Butte to Salt River Mountains.

As previously described in D. B. Heard's well, situated at the southwest corner of section 30, bowlders were encountered to a depth of 90 feet, beneath which granite wash occurs, probably from the mountains at the south. The wells at the Valley Seedless Grape Company's vineyard, 4 miles south of Tempe, and the two wells drilled in the same region by Mr. Heard indicate that the water-bearing bowlder bed hardly reaches that point. It is evident, all things considered, that the underflow so voluminous and extensive in the Mesa region does not find free passage to the Phoenix region past Tempe.

In explanation of this, there is a belief somewhat widespread in the valley that the passage is obstructed by a subterranean dam formed either by volcanic activity or by the formation of a cement reef across the valley. After what has been said of the formation of caliche, or cement, it seems evident that the continuous passage of the underflow would prevent any cement from forming across the valley which could in any sense act as a dam, and this postulate may be dismissed without further comment. The suggestion of a volcanic dam finds some con-

firmation in the presence of the andesite of Tempe and Bell buttes. As previously described, the uplift of Tempe Butte occurred in comparatively recent time, but whether the formations of the lava of Tempe and Bell buttes and the subsequent local movements occurred after the excavation of the valley or had anything to do with the obstruction of the underflow remains a matter of conjecture. In the mind of the writer, the phenomena about Tempe find most rational explanation in the change of the course of the river described below.

In order to place pumping plants where they will be most productive, it is a matter of prime importance to know the nature and course of

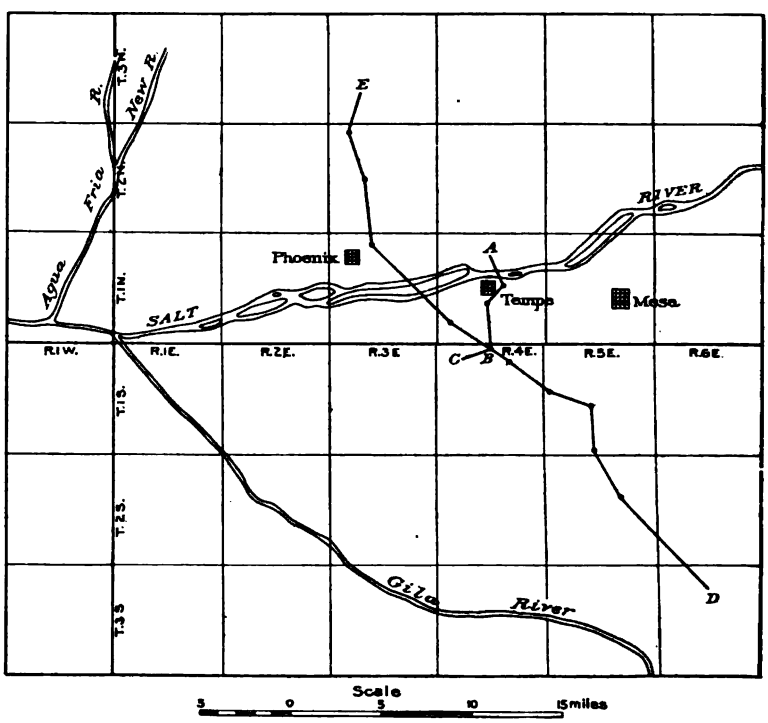


FIG. 20.—Index map of Salt River Valley, locating the sections shown in Pl. XXI.

the underflow. It is believed by some that the water is virtually stagnant and held in the gravels as water is held in a sponge. The "underground lake" is a familiar expression in the valley. A still more common expression is "the underground river." It is scarcely necessary, after what has been written, to explain that no underground lake and no underground river, taken in the popular sense, exist. There is, however, a slow movement of the underground water down the valley, which is designated as the underflow. Whether the underflow is as wide and as deep as the valley fill, or whether there are certain restrictions both laterally and vertically, directing the flow in certain courses, depends entirely upon the structure of the valley fill.

There is also to be considered the possibility that the ancient course of the river was not the same as the present course. Enough has been written to indicate that there are restrictions, and that the great volume of the underflow passes through a comparatively narrow space. The valley, filled as it has been both by wash from the hills and by sands and gravels brought down the river, would naturally yield abundant water only where the valley fill is sufficiently open to allow a free passage of water. The wash from the hills along the outer portions of the valley, while coarse enough to allow free passage of water in places, is very frequently cemented to a practically impervious mass. Some wells obtain a good supply from this wash, but there are many that have failed because they were in the wash. The most productive wells are in the beds of river gravel and bowlders.

ANCIENT RIVER CHANNELS.

Since it is always the river that is making the deposits of gravel and bowlders through which water passes most readily, it naturally follows that the bowlder beds mark the ancient courses of the river. It furthermore follows that the present course of the underflow is in general the course of the ancient river that deposited the gravels and bowlders in which the underflow occurs. It remains, then, to determine the old courses as accurately as possible in order to place the pumping plants in the most advantageous localities. At first thought this course should be in general down the valley, parallel to the river. But a little reflection indicates that this is not necessarily the case. As the floor of the valley was raised by the deposition of débris, the river shifted from side to side of the valley. When the level of the rising valley floor reached the saddle of some spur or divide the river might pass over this divide, leaving its former course at one side. This is probably what Salt River has done in comparatively recent times. On this point the following facts are to be noted:

(1) In the Mesa region water-bearing gravels occur to a depth of at least 620 feet (Murphy-McQueen well) and extend at least as far south as the Chandler well No. 5, 12 miles south of Mesa.

(2) It is in these gravels that some of the best producing wells of the valley are located.

(3) There is an obstruction of some kind, as previously described, preventing a free passage of the underflow downstream at Tempe. Such well records as are available indicate that the gravel-filled valley near Tempe may be comparatively shallow.

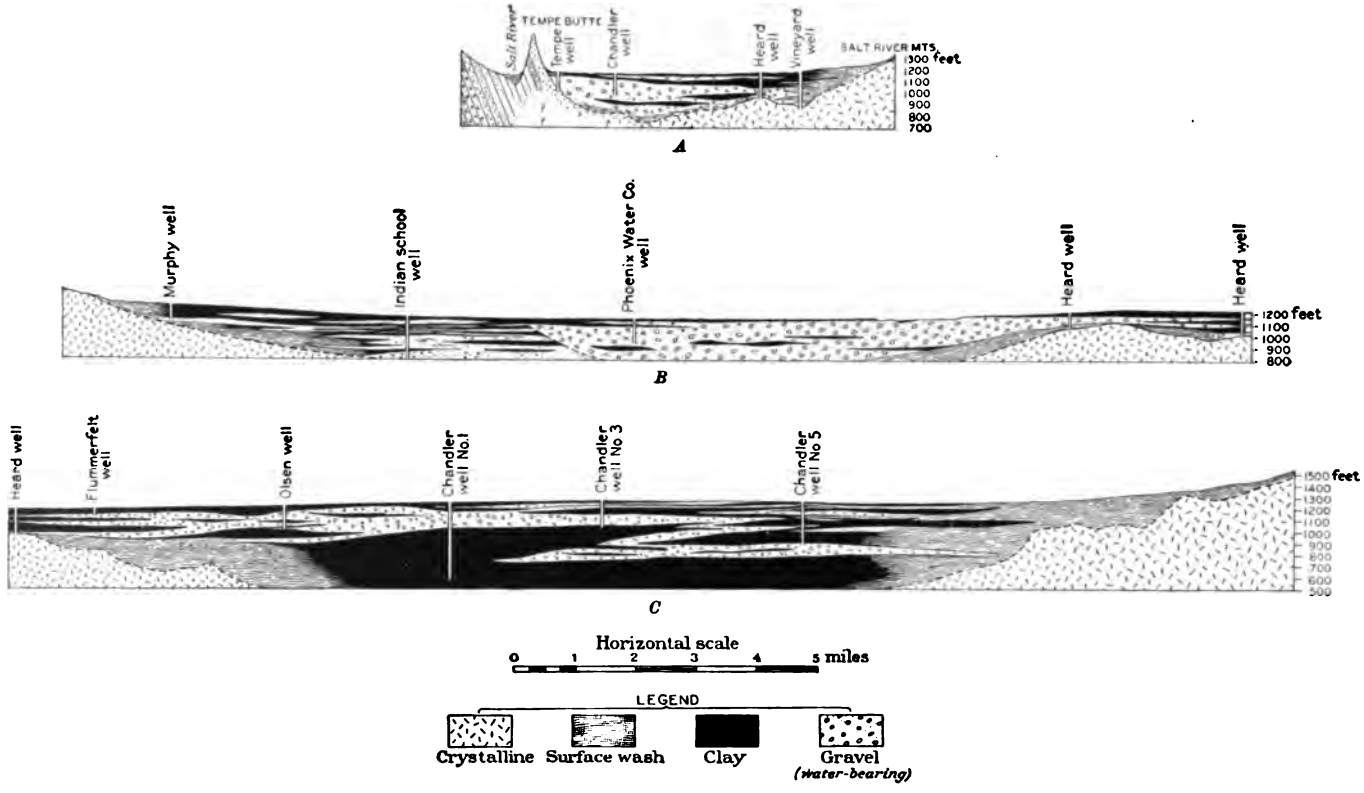
(4) Between Salt River Mountains and Sacaton Mountains is a broad and nearly level plain extending without interruption from the Mesa region to Gila River. It is an aggraded plain underlain by water-bearing gravels and connecting with the water-bearing gravels of the Gila, described in a previous paper by the writer.[a]

[a] Lee, W. T., Underground waters of Gila Valley, Arizona: Water-Sup. and Irr. Paper No. 104, U. S. Geol. Survey, 1904.

(5) At a point in Gila Valley where the waters passing as underflow through the gravels between the two groups of mountains just mentioned would naturally be expected to appear underground water returns to the surface in considerable quantity. At this point there is the somewhat novel phenomenon of a perpetual lake in the midst of a desert where evaporation is about ten times greater than the rainfall. This lake is not fed by Gila River, as is evident from the fact that the river is dry for a distance of about 50 miles above the lake during the greater part of the year. It is not fed from flood waters, since floods are seldom of sufficient volume to enter it. There is furthermore a constant and regular discharge of water from the lake. The only obvious source of supply is the underflow of Gila and Salt rivers.

An attempt has been made to show graphically the underground conditions across the valley at Tempe (Pl. XXI, *A*) and across the space between the Salt River Mountains and the Sacaton Mountains (Pl. XXI, *C*), so far as those conditions are known or can be reasonably inferred from the data at hand. It should be explained in this connection that these sections are so chosen as to pass through such deep wells as are known, thus making a section along a broken line. The depth of water-bearing gravels there indicated should not be interpreted as the depth of the passage open to the underflow. The crest of the subterranean ridge which is thought to exist is probably about a mile west of the line represented in section A, as indicated by the shallowness of the gravels at Heard's well and the sharp depression of the water table already described.

The evidence at hand leads clearly to the inference that in former ages Salt River joined the Gila east of the Salt River Mountains instead of occupying its present course north of those mountains. It has been argued with some degree of plausibility that the chemical character of the water throws doubt upon this hypothesis. The waters of the Salt River underflow as represented in the Olsen and Hansen wells, contain much greater quantities of salts than do the waters of the Gila underflow. It has been argued that waters so saline could not feed in any great measure an underflow such as that of Gila Valley. It should be noted, however, that the water from the Chandler wells farther to the east is less saline. For convenience of comparison there are placed, below, the analyses of four samples of the Gila underflow. (All water in this part of Gila Valley at ordinary times comes from the underflow.) In the same table are included the analyses of waters from the Salt River underflow, so selected as to give as wide a range as possible within the region which presumably feeds the Gila underflow. It appears from a comparison of these analyses that although the waters from the Hansen and Olsen wells are much more saline than the Gila underflow, those from the Chandler wells are



A. SECTION THROUGH TEMPE BUTTE TO SALT RIVER MOUNTAINS, ALONG THE BROKEN LINE A-B-C, FIG. 20.
B. SECTION ACROSS SALT RIVER VALLEY NEAR PHOENIX, LINE B-E, FIG. 20.
C. SECTION FROM SALT RIVER MOUNTAINS TO SACATON MOUNTAINS, LINE B-D, FIG. 20.

practically the same as the Gila underflow. It is entirely possible that the Chandler wells are in or near the course of freest flow where salts have either failed to find lodgment or if deposited in former times have been carried away by the comparatively free sweep of the waters, while the Olsen and Hansen wells may draw from water which, for some reason, is comparatively sluggish and therefore more saline, since the gravels in which it is held are not freely washed by a constant inflow of water.

Analysis of water from the underflow of Salt and Gila rivers, Arizona.

FROM GILA VALLEY.

	Lake in Gila Valley.	Cooperative Co.'s ditch, Gila Valley.	Gila River seepage.	Well at Presbyterian mission, Gila crossing.
Quantitative (parts in 100,000):				
Total solids soluble at 110° C	107.0	106.0	127.0	160.0
Chlorine in terms of NaCl (common salt)	61.2	62.8	76.4	110.8
Hardness in terms of $CaSO_4$ (sulphate of lime)	2.72	13.1	12.5	28.4
Alkalinity in terms of Na_2CO_3 (black alkali)	.....	.....	.....	.....
Nitrogen in the form of nitrates	.....	.....	.....	.....
Nitrogen in the form of nitrites	.....	.....	.....	.....
Qualitative:				
Sulphates	Very strong.	Strong.	Very strong.	Very strong.
Magnesia	Strong.	Strong.	Strong.	Strong.
Lime	Strong.	Strong.	Strong.	Strong.
Bicarbonates	Strong.	Strong.	Pronounced.	Strong.

FROM SALT RIVER VALLEY.

	Chandler well No. 1 (after 15 months' pumping).	Chandler well No. 1 (after 24 months' pumping).	Chandler well No. 3 (after thorough pumping).	Olsen well.	Hansen well (after several months of constant pumping).
Quantitative (parts in 100,000):					
Total solids soluble at 110° C	127.4	179.0	84.8	381.0	442.0
Chlorine in terms of NaCl (common salt)	75.6	116.8	44.6	235.2	311.0
Hardness in terms of $CaSO_4$ (sulphate of lime)	23.1	53.3	18.5	59.84	151.2
Alkalinity in terms of Na_2CO_3 (black alkali)	None.	None.	None.	None.	None.
Nitrogen in the form of nitrates	.07	Trace.	.266	2.0	Trace.
Nitrogen in the form of nitrites	Traces.	None.	Traces.	Faint.	.01
Qualitative:					
Sulphates	Strong.	Very strong.	Strong.	Very strong.	Very strong.
Magnesia	Distinct.	Strong.	Distinct.	Strong.	Strong.
Lime	Pronounced.	Strong.	Strong.	Very strong.	Very strong.
Bicarbonates	Strong.	Strong.	Very strong.	Very strong.	Distinct.

PRINCIPAL COURSES OF UNDERFLOW.

While it is not probable that the underflow in this region follows a channel that is in any sense well defined, there are without doubt courses along which the flow has a maximum velocity, and others along which it has a minimum velocity. It is entirely conceivable, also, that there are places where the water is virtually stagnant. The underflow may be compared with the water of a swamp. It is one body of water, but communications between various localities are not equally free as in the case of a lake. Nor is the flow conceived to be as nearly uniform as in the case of a river. The water finds its way through the gravels along paths of least resistance, sometimes straight and sometimes circuitous. It should not be inferred, therefore, from reference to the principal course of the underflow, that anything like a definite channel is meant.

From a consideration of all available data it seems clear that the ancient course of the river and the present course of a large part of the underflow are east of the Salt River Mountains. It is probable that at a comparatively late stage in the course of the accumulation of the valley fill the gradually rising floor of the valley reached the level of the saddle between the Salt River Mountains and the Phoenix Mountains and found a shorter and easier passage than the circuitous route around the former. As the valley floor was still farther raised by the deposition of débris, and as the river passed its aggrading and degrading stages previously described, its course may have changed repeatedly, sometimes north of the Salt River Mountains and sometimes east and south of them. While the débris accumulating along its course is deemed the chief cause of the lateral migrations of the river, certain changes may have been caused by volcanic action and local movements in the vicinity of Tempe, as previously suggested.

This postulate explains in a rational and natural way the peculiarities near Tempe already described. There is probably a subterranean dam across the present valley at Tempe, which prevents the passage of the principal part of the underflow. It is not a dam thrown across a previously existing valley, but one which was formerly a ridge at the side of the valley and which was buried by débris as the valley was filled. It is probable that only the waters from the upper horizons of the gravels of the Mesa region find their way over the top of this submerged ridge into the underflow of the Phoenix region.

SOURCES OF THE UNDERFLOW.

One of the most notable features about the valley fill in the Mesa region is the thick bowlder bed covered with impervious clay. It occurs in the center of the valley, while toward the sides the bowlders

give place to the finer material. The water in the bowlder bed is under considerable pressure, while above the clay which confines it occur water bodies of limited extent, forming what is locally known as the surface flow. In certain places the surface flow is under slight pressure, while in others it is under no pressure, but the underflow and the surface flow form a single water body, as evidenced by the definite water table. The questions naturally arise: How are the waters connected? whence do they come? and how do they get into the ground?

There are several possible sources—(1) rainfall soaking into the ground; (2) underground water in the form of springs or artesian flow entering the valley from foreign regions; (3) streams and sheet washes entering the valley from the surrounding hills during times of abnormal precipitation.

(1) The rainfall is so slight—an average of little over 7 inches per year in the valley—that it could supply but a very small part of the underground water known to exist, even if it did not evaporate before entering the soil to any great depth. It is probable, however, that little if any of the water from rains in the valley finds its way to the underflow. At best it could only join the surface waters owing to impervious clay and cement layers separating these waters from those beneath.

(2) The hills surrounding the valley are composed principally of crystalline rock. There is no known possibility of water entering the valley in any form of artesian flow, and springs from the hillsides are so small that they may be disregarded.

(3) The only source which is quantitatively adequate to supply the known amount consists of the streams, chief among which is the Salt River system. There seems to be little doubt that the underflow is connected directly with the river.

In order to understand clearly how the waters enter the underflow it is necessary to know how the valley fill was deposited. In former ages Salt River Valley was a broad, deep valley of erosion, at least 1,305 feet deeper than it is at present. How much deeper, is impossible to say, for no well has penetrated beyond that depth. By some change in the altitude of the land or change of climate, perhaps both, the streams were changed from degrading to aggrading streams. The water could no longer carry all of its load. River débris accumulated as it is still accumulating. The coarser material was dropped in the channel, while the clay and silt accumulated on the floodplain, and cement formed near its surface. As the channel became choked with gravels and bowlders the stream shifted gradually, covering the clay and cement already deposited, while these materials in turn slowly accumulated over the gravels and bowlders of the abandoned stream

courses. As the river swung from side to side of the valley, gravel and bowlder beds were always left in its wake; furthermore—and this is the key to the problem—wherever a bowlder bed was formed a bowlder train filling the old channel connected and probably still connects this bed with the mouth of Salt River Canyon, whence the water, together with its débris, issued then as it does now.

While Salt River was the main factor in the formation of the valley fill the tributary streams and sheet washes played some part. Each stream, no matter how small, left a train of gravel leading into the valley fill, and in a small way migrated from side to side, as did the river. Permanent streams, no matter how small, kept a constant connection with the river, and their ancient gravel trains probably still form comparatively free subterranean passages for water into the general underflow. But nowadays the small stream courses, even streams as large as Queen and Cave creeks, do not reach the river but are lost in the valley fill. Judging the past by the present, similar relations may have obtained then. Such streams as Queen and Cave creeks might form their valley trains from the hills into the main valley for a considerable distance, and perhaps form a considerable bed of loose material through which water would flow readily, but the connection with the bowlder beds of the main stream might be cut off by impervious beds of clay or cement. Such beds might form water pockets in the valley fill, and under certain conditions yield flowing wells. However, no water pockets have been found in Salt River Valley yielding flowing water.

At the present time, while the streams are depositing their débris in the bottoms of the valleys, the granitic hills about the valley are forming granitic sand which slowly works its way down to meet the advancing accumulation of the river fill. Judging the past by the present, the outer edge of the valley fill is composed largely of granitic sand or arkose. This material is more or less pervious, and the waters shed from the hillsides sometimes sink quickly into it. Since it is only on the old flood plains that impervious clay layers were formed, these layers, so potent in the middle of the valley, where they are penetrated by the wells, do not exist near the edges of the valley, where both clays and gravel beds pass laterally into the accumulations of arkose. Thus the water, whether from the river, or from a tributary stream, or from a sheet wash from the hillside, finds its way always downstream into and through the valley fill underneath the impervious layers or wherever the trains or sheets of gravel lead.

The gravel trains thus form a network through the valley fill, connecting the principal bowlder beds, and leading back in every case to the stream which formed them. It is evident, therefore, that the underflow, although seemingly divided by impervious layers, is one

body of water, although the avenues of communication may be extremely tortuous and complicated. It thus results that the water of the underflow, whether from an upper or an under stratum, rises to a definite level which forms a comparatively uniform "water table," the gradient and local variations of the table being due to the varying resistance offered by the gravels to the passage of the water.

THE PHOENIX REGION.

The physical features of the Phoenix region differ in but few important respects from those of the Mesa region, and need be described only in so far as they differ in some essential manner. The principal part of this area consists of a broad plain, sloping gently southward to Salt River. Cave Creek enters the region from the north, and is lost upon the plain in a manner resembling that of Queen Creek in the Mesa region. At the western border of the region the Agua Fria and New River have definite channels extending over the plain to join the Gila.

DISTRIBUTION OF MATERIAL.

At the eastern border of the region granites, lavas, and the older sediments occur, as described in Chapter II. From Tempe westward to the Crosscut canal and thence northward and westward the valley fill abuts more or less abruptly against the older formations. The asylum well penetrates gravels to the depth of 110 feet without reaching bed rock, while 2 miles to the east bed rock appears at the surface. In the Murphy well, 325 feet deep, 115 feet of valley fill is penetrated, below which the breccia is encountered. Two miles to the east the breccia emerges from the surface to form the buttes north of Tempe.

In the southern portions of the region near the river the valley fill, as indicated by the well records, is composed mainly of river gravels and bowlders. It appears, from the occurrence of gravels in the Heard and McCallum wells, that the bowlder bed continues well southward toward the mountains. This southward extension is in harmony with the southward trend of the streams at the present time, as well as the southward trend of the ancient river, as indicated by the bowlder beds and the underflow of the Mesa region. While it is always unsafe to make predictions in matters so uncertain as underground conditions, the indications so far as known point to more favorable conditions for pumping south of Salt River than north of it.

A study of the well records in the light of what has already been said respecting surface oscillations, and the resulting stages of degradation and aggradation, leads to the belief that the bowlder bed underlying Phoenix is somewhat abruptly terminated at the north, as indicated in the section, Pl. XXI, *B*. The several wells in the vicinity of Phoenix enter bowlder beds differing in no essential manner from

those in the Mesa region except that they are, so far as known, comparatively free from cement. Three miles north of the Phoenix waterworks, the Indian School wells penetrate no bowlder beds nor any material that could not rationally be attributed to the action of small streams from the north and to wash from the hills. At some point, therefore, in the 3 miles intervening between the Phoenix well and the Indian School there is a transition from the bowlder bed to comparatively fine material. This transition has been shown in the section as abrupt, since the bowlder bed is regarded as equivalent to the younger beds of the Mesa region, while the finer material corresponds in age to the older Mesa gravels. During the stage of degradation intervening between the two periods of accumulation it is thought that a broad valley was cut in the older deposits similar to that described in the Mesa region, and that during the later accumulation this valley was not only filled, but the bordering bluffs were buried by the younger accumulation.

North and west of Phoenix gravel beds are few, and sand, cement, and wash make up the principal part of the valley fill. While there are a great many drilled wells in this region, there are few for which definite records were kept. The meager data obtainable are noted in Chapter I. Several wells reach gravel beds, but the extent of such gravels is unknown. Since, with few exceptions, the wells are small, being intended only for domestic use, they do not penetrate through the gravel beds. A few wells, such as the Bartlett well, the Kellner well, and the Indian School wells, have been sunk deep enough to indicate that the bowlder beds of the southern part of the Phoenix region do not extend far to the north. No accurate record of either the Bartlett well or the Kellner well is obtainable. It is thought, however, that had bowlder beds been encountered, their presence would be known, if for no other reason, because drilling machinery such as was employed in constructing these wells has proved inadequate to go through bowlders such as are found in the southern part of the region. It is probable that gravel beds of considerable volume occur, but they seem to be more or less separated. If water pockets are to be found in Salt River Valley with water under pressure sufficient to produce flowing wells, it would appear from theoretical considerations that the northern part of the Phoenix region is the place where they might reasonably be expected; but while many shallow wells have been sunk in this region, no well has yet penetrated to a sufficient depth to test this possibility. The Bartlett well, 311 feet deep, is the deepest well put down, and, according to the best account to be obtained, water under considerable pressure was encountered.

GEOGRAPHIC CHANGES.

On account of the great importance of this subject to those who may consider the construction of wells for irrigation purposes, emphasis is put on it at the risk of repetition. During stage B (see fig. 14) a thickness of more than 1,300 feet of débris was deposited in the Mesa region, closing with the great bowlder beds. During the greater part of this time, and perhaps until the close of stage B, Salt River flowed east of Salt River Mountains. The Phoenix region in the meantime was without the controlling influences of Salt River. Its aggradation was due to wash from the hills and to the débris of comparatively small streams. The material thus brought into the valley was comparatively fine; some of the larger streams formed gravel beds, but no great accumulation of bowlders took place. During stage C Salt River was flowing in or near its present course north of Salt River Mountains, and was cutting away the deposits previously laid down, and at the same time was deepening a passage through the rock ridge near Tempe. This passage is narrow, as would naturally be expected, on account of the hardness of the rock.

During the second period of accumulation (D) the new channel, or secondary valley, was filled, as was the case in the Mesa region, and since this secondary valley in the Phoenix region was now the course of the river, it was filled principally with coarse material, and to an extent sufficient to bury the bluffs, obliterating from the surface all evidence of such a valley. The recent river accumulations of the Mesa region and the bowlder beds of the Phoenix region are regarded as equivalent and directly connected through the comparatively narrow passage at Tempe.

WATER TABLE.

From what has been written it appears that the water table of the Phoenix region assumes neither the definiteness nor the importance of the water table in the Mesa region, where there is free communication between the water-bearing formations. At certain points in the Phoenix region communication seems to be wanting, as is shown in the Indian School well; at other places communication is poor. The water supply in the northern part of the Phoenix region is comparatively limited, and yet there is an inclination of the water table in places of 20 feet or more to the mile. Such a gradient could scarcely be maintained unless the passages through which the water finds exit presented formidable obstructions.

EXTENT OF BOWLDER BEDS.

The northern boundary of the bowlder bed west of Phoenix is not known. The Harris well is 7 miles west of Phoenix and 5 miles north of the river; the ostrich-farm well is 9 miles west of Phoenix and 5 miles north of the river; and the Kellner well is 14 miles west of Phoenix. The bowlder bed of the southern part of the Phoenix region was not encountered in either of these wells. It is probable that the bowlder bed will not be found much, if any, north of the Salt River canal. Thence northward the chances of finding water sufficient for successful pumping plants grow progressively less, (1) because of the increasing depth to water; (2) because of the scarcity of water-bearing material; (3) because of the limited supply of water; and (4) because of the evident want of easy communication between the various beds of water-bearing material. So far as known the underground water throughout the Phoenix region is amply sufficient for domestic use. Certain wells would probably yield a moderate supply for irrigation for a time. It is evident, however, that a pumping plant to be permanently successful must be in such a position as to draw freely from the underflow of the river, the only permanent and adequate supply. Extensive pumping would soon exhaust the limited supply from the north. If my interpretation of the underground conditions, as indicated in the history of the valley fill and presented graphically in the section across the valley (Pl. XXI), be correct, it is probable that pumping on an extensive scale would not be permanently successful anywhere north of an east-west line passing 1 or 2 miles north of Phoenix.

South of this line, however, there is every indication that pumping plants could be successfully operated. The known volume of the bowlder bed near Phoenix indicates that a similar volume is to be expected downstream. The great productiveness of the pumping plants now in operation near Phoenix, described in Chapter I, indicates an abundant water supply wherever the bowlder bed is found. The readiness of movement evidenced by the large output, and the rapidity with which the water regains its normal level in the wells when the pumps stop, indicate conditions most favorable for profitable pumping. The return of the underflow to the surface a few miles west of Phoenix and thence westward, making a surface flow of considerable volume in the Buckeye region, indicates a volume of underflow which promises permanency of supply.

CHAPTER IV.

ECONOMICS.

It remains to inquire into the practical application of the information presented in the preceding chapters. The end in view is the determination of the quantity of underground water available for irrigation, its adaptability for use in irrigation, and the best means of obtaining it. To this end I shall consider the area in which the underflow occurs, the chemical character of the waters, the volume of the underflow, the cost of pumping, and the location of pumping stations.

AREA OF PROFITABLE PUMPING.

The utility of pumping plants is determined largely by two considerations: First, the lift; and, second, the freedom of movement of the

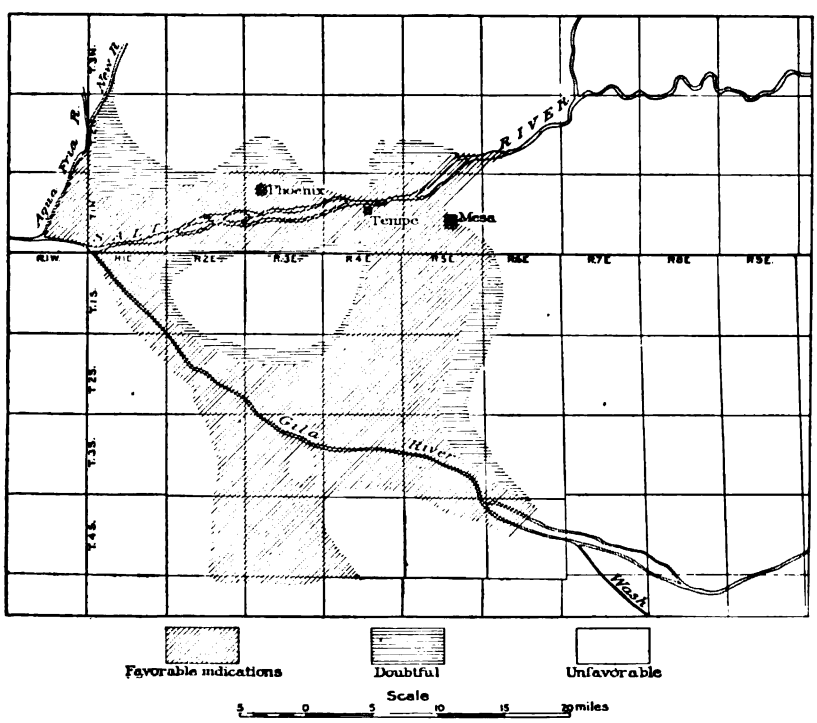


FIG. 21.—Map of Salt River Valley, showing area beneath which water is 50 feet or less below surface.

underground waters. The limit of lift, or total height to which the water may be profitably raised, can only be determined by the cost of pumping and the value of the water obtained. With certain crops

water yields larger returns than with others. On the other hand, there are localities in the valley, as shown in the last chapter, where pumping plants can not secure water from the gravels rapidly enough to make their operation profitable. The underground conditions are so variable that the selection of sites for pumping plants must depend largely on experiment in each case. In fig. 21 is indicated the area where pumping plants would probably be profitable and the area where their success would be doubtful. The line of demarcation can not be accurately drawn at present and the map should not be interpreted in this regard too literally.

The delimitations dependent on the lift can be drawn with more accuracy. Assuming a lift of 65 feet as the maximum for economic pumping, and assuming 15 feet as the average local depression of the water table in the wells through the action of the pumps, it follows that the boundary of the area thus denoted is the contour indicating a depth of 50 feet to water. The contour maps now available do not cover the southern portion of the area indicated. The boundaries are taken from the contour maps as far south as the base line; south of that line the boundaries are approximately correct. The outline of the area in Gila Valley indicating an approximate depth of 50 feet to water is also appended. This outline is taken from a map included in a former paper by the writer on the underground waters of Gila Valley.[a]

CHEMICAL CHARACTER OF GROUND WATER.

The water analyses quoted in this paper were made for the most part at the chemical laboratory of the Arizona Experiment Station at Tucson, by Prof. R. H. Forbes and W. W. Skinner. In addition Mr. Thos. H. Means, formerly of the United States Department of Agriculture, has kindly furnished a table of analyses made by himself some years ago. In so far as the analyses apply to the waters of Salt River Valley they are gathered into the following tables, arranged according to the methods of analysis:

[a] Lee, W. T., Underground waters of Gila Valley, Arizona: Water-Sup. and Irr. Paper No. 104, U. S. Geol. Survey, 1904.

Chemical analyses of waters in or near Salt River Valley, Arizona.[a]

[Parts in 100,000.]

Number.	Owner.	Location. Township.	Location. Range.	Location. Section.	Date.	Depth of well.	Total solids soluble at 110° C.	Chlorine, NaCl (common salt).	Hardness, $CaSO_4$ (sulphate of lime).	Alkalinity, Na_2CO_3 (black alkali).	Nitrogen in the form of nitrites.	Nitrogen in the form of nitrates.	Qualitative. Sulphates.	Qualitative. Magnesia.	Qualitative. Lime.
						Feet.									
2815	Perry Williams, Maricopa				Mar. 19, 1902	35	100.9	50.0	24.48	.....	Faint.	0.20	Very strong.	Very strong.	Strong.
2816	Railroad Co., 1¼ miles west Maricopa				.....do	.....	39.8	6.4	5.41	.....	Very faint.	.104	Strong.	Strong.	Faint.
2082	Alhambra town well	2 N.	2 E.	26	Sept. 16, 1898	50	116.3	56.0	.....	34.13	.....	.05	.....	.....	.....
2083	A. H. Smith	2 N.	2 E.	21	.....do	95	130.5	40.0	Strong.	.....	0.012	10.0	.....	.....	.....
2084	Frank Alkire	2 N.	2 E.	21	.....do	96	41.1	10.0	Strong.	.....	.0004	1.5	.....	.....	.....
2085	—— Barkley	2 N.	2 E.	17	.....do	90	340.8	68.0	Strong.	.....	.0084	16.0	.....	.....	.....
2086	—— Boyer	.....	.....	.....	.....do	80	234.5	149.0	Strong.	.....	.....	.60	.....	.....	.....
2087	W. S. McClain	2 N.	2 E.	18	.....do	80	117.6	29.0	Strong.	.....	.016	7.0	.....	.....	.....
2088	Town well, Glendale	2 N.	2 E.	5	.....do	90	79.2	39.0	Strong.	.....	.0003	.....	.....	.....	.....
2089	—— Bartlett	3 N.	2 E.	30	.....do	140	53.1	17.0	Strong.	.....	.....	.80	.....	.....	.....
2090	—— Mosher	2 N.	2 E.	9	.....do	70	346.4	112.0	Very strong.	.....	.....	1.0	.....	.....	.....
2091	G. B. Morgan	2 N.	1 E.	5	.....do	40	46.2	10.0	Strong.	.....	.0028	.40	.....	.....	.....
2150	B. A. Fowler	3 N.	2 E.	33	June 30, 1899	.....	80.9	13.2	36.5	.....	.....	.....	.....	.....	.....
2619	W. J. Murphy	.....	.....	.....	June 8, 1901	.....	115.8	35.6	46.11	.....	.....	.....	Very strong.	Very strong.	.....
2620	J. B. Doner	.....	.....	.....	.....do	.....	143.6	44.8	53.2	.....	.....	.....	Very strong.	Very strong.	Very strong.
2621	H. B. Lehman	2 N.	2 E.	6	.....do	.....	91.2	30.8	35.8	.....	.....	.....	Strong.	Very strong.	Strong.
2622	A. J. Straw	3 N.	1 E.	25	.....do	.....	188.6	81.0	.....	.....	.....	.....	.....	.....	.....
2623	A. W. Bennet	.....	.....	.....	.....do	.....	31.0	5.6	.....	.32	.....	.....	Faint.	Faint.	Faint.
2624	E. E. Jack	.....	.....	.....	.....do	.....	57.9	9.6	.....	4.35	.....	.....	Pronounced.	Faint.	Pronounced.
	MESA.														
1506	H. L. Chandler	.....	.....	.....	Nov. 24, 1896	.....	103.6	Very strong.	.....	.....	.....	.....	Strong.	.....	.....
1515	A. J. Chandler	.....	.....	.....	Feb. 1, 1897	.....	166.6	Very strong.	.....	.....	.....	.....	Faint.	.....	Faint.
1517	.....do	.....	.....	.....	.....do	.....	179.4	Very strong.	.....	.....	.....	.....	Strong.	.....	Strong.

[a] Taken from tables in The Underground Waters of Arizona, by W. W. Skinner, Ariz. Agric. Exp. Sta. Bull. 46.

Chemical analyses of waters in or near Salt River Valley, Arizona—Continued.

Number.	Owner.	Location.			Date.	Depth of well.	Total solids soluble at 110° C.	Chlorine, NaCl (common salt).	Hardness, $CaSO_4$ (sulphate of lime).	Alkalinity, Na_2CO_3 (black alkali).	Nitrogen in the form of nitrites.	Nitrogen in the form of nitrates.	Qualitative.		
		Township.	Range.	Section.									Sulphates.	Magnesia.	Lime.
	MESA—Continued.					*Feet.*									
2615	Murphy-McQueen..	1 N.	5 E.	34	May 17, 1901	1,305	133.2	82.0	11.15	.....	0.0067	0.43	Very strong.	Very strong.	Very strong.
2724	A. J. Chandler.....	1 S.	5 E.	22	Aug. 27, 1901	150	174.2	110.7	47.02	.....	Slight trace.	.07	Strong.	Very strong.	Strong.
2775	.....do.....	1 S.	5 E.	22	Dec. 5, 1901	.....	176.2	111.1	42.6	.....	None.	.02	Very strong.	Very strong.	Very strong.
2804	.....do.....	1 S.	5 E.	23	Jan. 28, 1902	54	103.2	48.8	.....	7.63	.0094	.21	Strong.	Faint.	Faint.
2818	.....do.....	1 S.	5 E.	22	Mar. 9, 1902	705	157.4	104.0	39.3	.....	Very faint.	.12	Very strong.	Very strong.	Very strong.
2819	.....do.....	1 S.	5 E.	22	.....do.....	146	172.2	110.0	45.3	.....	Very faint.	.12	Very strong.	Very strong.	Very strong.
2820	.....do.....	1 S.	5 E.	22	.....do.....	236	163.8	104.4	44.5	.....	Very faint.	.12	Very strong.	Very strong.	Very strong.
2977	.....do.....	1 S.	5 E.	22	Feb. 6, 1903	240	299 6	154.8	20.9	.....	.0105	.29	Very strong.	Strong.	Strong.
2983	.....do.....	1 S.	5 E.	34	Mar. 7, 1903	260	162.4	80.4	52.2	.....	.0061	.27	Very strong.	Strong.	Very strong.
3157	.....do.....	1 S.	5 E.	22	June 13, 1903	236	127.4	75.6	23.1	.....	Faint.	.17	Strong.	Faint.	Pronounced.
3158	.....do.....	1 S.	5 E.	34	.....do.....	.....	84.8	44.6	18.5	.....	Faint.	.26	Strong.	Faint.	Strong.
3138	Desert well.....	1 S.	7 E.	11	May 14, 1903	212	32.0	5.2	.....	4.66	Very faint.	.49	Faint.	Very faint.	Faint.
3141	E. Olsen.....	1 S.	5 E.	18	.....do.....	212	381.0	235.2	59.8	.....	Faint.	2.0	Very strong.	Strong.	Very strong.
3144	P. Mets.....	1 N.	5 E.	22	.....do.....	56	167.8	108.0	.....	9.33	Very faint.	.38	Strong.	Faint.	Strong.
3145	Alhambra Hotel....	1 N.	5 E.	22	.....do.....	51	152.0	89.6	.....	5.51	Very faint.	.33	Strong.	Faint.	Strong.
3146	Dorman Bros.....	1 N.	6 E.	33	.....do.....	100	114.0	74.0	.....	.....	.....	.....	Strong.	Very faint.	Strong.
	PHOENIX.														
1819	Fowler Bros.....	1 N.	1 E.	1	Apr. 30, 1897	.....	399.3	Very strong.	.....	.....	.....	.....	Very strong.	Strong.	Faint.
2017	Mrs. W. J. Murphy.	.....	.....	.....	Aug. 15, 1898	.....	334.3	107.0	.....	.....	.05	10.0	34.3	3.64	10.5
2067	North Central Avenue.....	.....	.....	.....	Sept. 15, 1898	.....	117.7	66.5	.....	.....	None.	.20	.....	.....	.....
2068	School, Central Avenue.....	1 N.	3 E.	5	.....do.....	.....	216.1	150.0	.....	.....	.....	.20	.....	.....	.....
2069	Indian School.....	2 N.	3 E.	20	.....do.....	15	222.0	141.0	.....	33.36	.0008	Faint.	.....	.....	.....
2070	.....do.....	2 N.	3 E.	20	.....do.....	60	362.3	258.0	Strong.	.....	.0028	.30	.....	.....	.....

2981	.....do.....	2 N.	3 E.	20	Mar. 7, 1903	45	245.2	160.8	21.8	.....	Faint.	.40	Very strong.	Very strong.	Very strong.
2982	.....do.....	2 N.	3 E.	20	.....do.....	145	250.0	145.6	65.8	.....	.004	.25	Very strong.	Very strong.	Very strong.
2071	Ida E. Lawrence...	2 N.	3 E.	20	Sept. 15, 1898	30	413.1	285.0	Strong.	.....	.....	.60	.....	.....	.....
2073	—— Cawthorn....	2 N.	3 E.	29(?)	.....do.....	65	97.6	61.0	Strong.	.....	.0006	.40	.....	.....	.....
2074	Orangewood	2 N.	3 E.	4(?)	.....do.....	105	44.9	16.0	Strong.	.....	.0016	.80	.....	.....	.....
2075	J. A. Wieder.....	3 N.	3 E.	32	.....do.....	146	76.1	31.5	Strong.	.....	.0078	.70	.....	.....	.....
2076	W. R. Beshier	2 N.	3 E.	20(?)	.....do.....	36	126.9	43.0	.....	39.2	.....	.10	.....	.....	.....
2077	—— Churchill....	2 N.	3 E.	20(?)	.....do.....	92	284.6	103.0	Strong.	.....	.0004	.80	.....	.....	.....
2078	.....do.....	2 N.	3 E.	20(?)	.....do.....	70	531.8	179.5	Strong.	.....	.043	2.10	.....	.....	.....
2079	M. Morrison.....	2 N.	3 E.	32(?)	.....do.....	28	287.5	203.0	Strong.	.....	.0002	.80	.....	.....	.....
2080	Wm. Christy.....	1 N.	2 E.	1	.....do.....	22	150.6	84.0	Strong.	.....	.....	.05	.....	.....	.....
2081	G. R. Brewster	2 N.	2 E.	36	.....do.....	35	122.5	44.5	.....	33.63	.0004	.40	.....	.....	.....
2095	Phoenix city supply	1 N.	3 E.	4	Sept. 18, 1898	42	116.8	72.5	Strong.	.....	.0007	.10	.....	.....	.....
2840	.....do.....	1 N.	3 E.	4	May 9, 1902	42	102.4	54.6	8.98	.....	.0045	.16	Very strong.	Very strong.	Very strong.
3139	.....do.....	1 N.	3 E.	4	May 14, 1903	208	132.0	77.6	5.4	.....	Very faint.	.25	Pronounced.	Pronounced.	Strong.
3140	.....do.....	1 N.	3 E.	4	.....do.....	42	136.0	80.8	6.5	.....	.021	.25	Pronounced.	Pronounced.	Strong.
2143	G. R. Brewster.....	2 N.	2 E.	36(?)	June 30, 1899	.....	103.4	36.5	.....	34.87	.0006	.02	.....	.....	.....
2215	Dr. Duffield	.....	.....	.....	Oct. 24, 1899	.....	75.3	35.0	.....	2.3	.....	.....	Strong.	None.	Faint.
2216	.....do.....	.....	.....	.....	.....do.....	.....	68.8	32.0	.....	4.0	.....	.....	.....	.....	.....
1612	C. W. Perkins	2 N.	3 E.	23	May 10, 1901	155	83.6	30.8	8.3	.....	.0871	.53	Very strong.	Strong.	Strong.
2625	W. J. Murphy	.....	.....	.....	June 8, 1901	.....	28.2	3.1	.....	2.12	.....	.....	Faint.	Pronounced.	Faint.
2696	.....do.....	.....	.....	.....	July 3, 1901	.....	27.6	3.1	.....	2.42	Faint.	.47	Very faint.	Faint.	Faint.
2774	B. Smith	.....	.....	.....	Oct. 14, 1901	25	235.8	153.5	12.10	.....	.0029	.31	Very strong.	Very strong.	Very strong.
2837	Thomas Murphy ...	2 N.	4 E.	30	Apr. 22, 1902	187	380.4	140.0	10.88	.....	.40	2.33	Very strong.	Very strong.	Very strong.
2838	.....do.....	2 N.	4 E.	30	.....do.....	168	303.2	136.0	26.65	.....	.80	2.70	Very strong.	Very strong.	Very strong.
2839	.....do.....	2 N.	4 E.	30	.....do.....	78	388.0	105.0	.....	45.16	.0666	1.43	Very strong.	Very strong.	Very strong.
2842	.....do.....	2 N.	4 E.	30	May 9, 1902	325	325.8	123.4	32.1	.....	.0073	.66	Very strong.	Very strong.	Very strong.
2845	J. Miller.....	2 N.	2 E.	33	May 27, 1902	.....	239.0	89.8	.....	.....	.....	.....	Very strong.	Very strong.	Very strong.
2849	Asylum.....	1 N.	3 E.	2	June 12, 1902	42	120.4	79.2	8.2	.....	Faint.	Faint.	Very strong.	Very strong.	Very strong.
2949	.....do.....	1 N.	3 E.	2	Oct. 31, 1902	90	126.4	78.8	13.6	.....	Very faint.	Very faint.	Very strong.	Strong.	Strong
2960	Soap Springs, 50 miles north.....	.....	.....	.....	Jan. 5, 1903	.....	272.2	52.4	.....	144.6	.....	.....	Strong.	Faint.	Faint.
2970	A. C. Bartlett.....	2 N.	3 E.	32	Jan. 2, 1903	60	164.0	102.8	6.8	.....	Faint.	.66	Very strong.	Very strong.	Strong.
2342	J. J. Harris	1 N.	2 E.	6	May 14, 1903	103	268.0	185.0	34.8	.....	Very faint.	2.0	Strong.	Strong.	Very strong.

Chemical analyses of waters in or near Salt River Valley, Arizona—Continued.

Number.	Owner.	Location. Township.	Range.	Section.	Date.	Depth of well.	Total solids soluble at 110° C.	Chlorine, NaCl (common salt).	Hardness, $CaSO_4$ (sulphate of lime).	Alkalinity, Na_2CO_3 (black alkali).	Nitrogen in the form of nitrites.	Nitrogen in the form of nitrates.	Qualitative. Sulphates.	Magnesia.	Lime.
	PHOENIX—Cont'd.					*Feet.*									
3143	H. Thompson	2 N.	3 E.	8	May 14, 1903	104	26.0	4.0	.....	4.88	0.126	0.33	Faint.	Very faint.	Very faint.
3187	Mission (Presbyterian), Gila Crossing	.....	.....	.....	Aug. 25, 1903	.....	160.0	110.8	28.4	.0	.....	.....	Very strong.	Strong.	Strong.
3184	Lake near Gila Crossing	.....	.....	.....	do	.....	107.0	61.2	2.72	.0	.....	.....	Very strong.	Strong.	Strong.
3185	Cooperative ditch, Gila Crossing	.....	.....	.....	do	.....	106.0	62.8	13.1	.0	.....	.....	Strong.	Strong.	Strong.
3186	Gila River at Gila Crossing (seepage)	.....	.....	.....	do	.....	127.0	76.4	12.5	.0	.....	.....	Very strong.	Strong.	Strong.
3204	S. W. Nigh	2 N.	4 E.	36	Sept. 19, 1903	.....	110.0	60.0	.....	.....	.....	.....	Pronounced.	Very faint.	Pronounced.
3203	N. J. Murphy	2 N.	4 E.	30	do	.....	193.0	74.0	.....	.....	.....	.....	Very strong.	Very faint.	Very faint.
3202	—— Underhill	2 N.	4 E.	22	do	.....	189.4	93.0	.....	.....	.....	.....	Very strong.	Pronounced.	Strong.
3201	—— Warner	2 N.	4 E.	8	do	120	52.0	17.0	.....	.....	.....	.....	Pronounced.	Very faint.	Pronounced.
	Geo. U. Collins	1 N.	2 E.	15	Aug. 25, 1903	29	150.0	94.8	17.40	.0	.....	.....	Strong.	Strong.	Strong.
	L. Kunz	1 N.	3 E.	18	do	24	223.0	146.8	53.7	.0	.....	.....	Very strong.	Strong.	Very strong.
	J. Heaton	1 N.	1 W.	15	do	45	28.0	5.2	1.09	.0	.....	.....	Pronounced.	Pronounced.	Pronounced.
2092	H. L. Underhill	2 N.	4 E.	22	Sept. 17, 1898	61	84.4	50.0	Strong.	.....	.....	.15	.....	.....	.....
2093	Geo. Blont	2 N.	4 E.	26	do	40	159.4	90.0	.....	.....	.....	.40	.....	.....	.....
2795	Winfield Scott	2 N.	4 E.	23	Jan. 9, 1902	67	167.4	100.8	42.7	.....	.001	.50	Very strong.	Very strong.	Very strong.
2796	Paradise Valley	.....	.....	.....	do	.....	25.6	5.72	1.6	.....	.0049	.35	Faint.	Pronounced.	Pronounced.
2961	Winfield Scott	2 N.	4 E.	23	Dec. 5, 1902	60	171.4	91.2	21.22	.....	.....	.....	Very strong.	Very strong.	Strong.
	TEMPE.														
1525	J. W. Johnson	1 N.	4 E.	27	Mar. 15, 1897	11	79.2	Strong.	.....	.....	.....	.....	Faint.	.....	.....
2110	Hough's creamery	1 N.	4 E.	23	Dec. 2, 1898	.....	103.0	67.0	Strong.	.....	.....	.....	.....	.....	.....

2111	Hough's ranch				Dec. 2, 1898	8	188.5	109.0	Strong.		.0004	.30			
2113	J. W. Wolf	1 N.	4 E.	23	do	15	160.0	94.0	Strong.		.0012	.20			
2114	J. B. Mullen	1 N.	4 E.	35	do	13	287.6	192.0	Strong.		.0004	.25			
2115	W. T. Fowler				do	12	163.1	88.5		26.82	.0028	.30			
2116	Niels Peterson	1 N.	4 E.	29	do	20	221.8	141.5		24.91	.0004	.20			
2118	A. P. McKern	1 N.	3 E.	6	do		171.5	110.0	6.8		.0004	.05			
2303	Wolf & Jones				Mar. 28, 1900		128.8	80.8	12.0		.0006	.30			
2304	do				do		190.4	120.0	6.1			.25			
2339	Hotel Casa Loma	1 N.	4 E.	15	May 7, 1900		169.8	105.8	12.9		.0027	.18	Very strong.	Pronounced.	Very strong.
2748	Geo. Kinney				Oct. 17, 1901	40	202.6	130.5	8.16		None.	.25	Strong.	Very strong.	Strong.
2766	Normal School	1 N.	4 E.	22	Nov. 19, 1901	30	219.2	133.6	15.78		None.	.51	Very strong.	Very strong.	Very strong.
2966	A. R. Jenkins	1 N.	4 E.	19	Jan. 2, 1903	50	217.0	142.4		3.6	.004	.20	Very strong.	Strong.	Strong.
2967	do	1 N.	4 E.	19	do	50	223.0	171.2		3.4			Very strong.	Strong.	Strong.
2968	A. J. Hansen	1 S.	4 E.	35	do	156	509.0	355.0	60.9				Very strong.	Very strong.	Very strong.
2980	do	1 S.	4 E.	35	do	156	446.8	307.0	135.4		Faint.	Faint.	Very strong.	Very strong.	Very strong.
2969	H. L. Chandler	1 N.	4 E.	21	do	180	224.0	146.0		2.12			Very strong.	Very strong.	Strong.
2973	Tempe city supply				Jan. 8, 1903	200	103.0	58.8	9.52		None.	.17	Strong.	Strong.	Strong.
3118	Valley Seedless Grape Co	1 S.	4 E.	4	Mar. 19, 1903	200	115.2	78.6	11.4				Strong.	Pronounced.	Strong.
3119	do	1 S.	4 E.	4	do	300	155.8	105.4	21.8				Strong.	Pronounced.	Strong.
2226	Salt River				Nov. 17, 1899		134.5	81.8			.04	.10			
2251	A. R. Jenkins ditch	1 N.	4 E.	20	Dec. 26, 1899		189.4	136.0		8.4			Very strong.	Strong.	Very strong.
2252	do	1 N.	4 E.	20	do		216.4	142.9		7.7			Strong.	Strong.	Strong.
2285	Buckeye canal				Mar. 5, 1900		182.0	119.2	23.1		.0032	.126	Very strong.	Strong.	Very strong.
2286	Richardson ditch	1 N.	1 W.	(?)	do		30.0	6.0		1.17	.004	.16	Strong.	Strong.	Strong.
2340	do	1 N.	1 W.	(?)	May 21, 1900		33.4	7.4		1.3	Faint.	.148	Strong.	Strong.	Strong.
2287	Salt River seepage, Phoenix				Mar. 5, 1900		130.0	86.4		.32	.0064	.30	Strong.	Strong.	Very strong.
2288	Salt River at Tempe				Mar. 5, 1900		118.0	79.6	10.2		.008	.22	Strong.	Strong.	Very strong.
2289	Salt River at Arizona dam				do		102.2	68.4	.62			.20	Strong.	Strong.	Strong.
2293	Agua Fria underflow, Buckeye				Mar. 6, 1900		78.4	32.2	1.50		Faint.	.08			
2341	Buckeye canal				May 21, 1900		185.0	121.8	23.4		Faint.	.165	Very strong.	Very strong.	Very strong.
	Lewis Wetzler	1 N.	3 E.	11	Sept. 19, 1903	40	144.0	86.0	23.9	0.0			Pronounced.	Very faint.	Strong.

Chemical analyses of waters in or near Salt River Valley, Arizona—Continued.

Number.	Owner.	Location.			Date.	Depth of well.	Total solids soluble at 110° C.	Chlorine, NaCl (common salt).	Hardness, $CaSO_4$ (sulphate of lime).	Alkalinity, Na_2CO_3 (black alkali).	Nitrogen in the form of nitrites.	Nitrogen in the form of nitrates.	Qualitative.		
		Township.	Range.	Section.									Sulphates.	Magnesia.	Lime.
	TEMPE—Cont'd.					*Feet.*									
3154	C. T. Sharp, Sacaton	.....	.....	.....	May 20, 1903	30	132.6	66.8	29.4	.....	0.031	0.083	Very strong.	Strong.	Very strong.
3156	Beet-sugar factory	2 N.	2 E.	8	June 10, 1903	112	54.6	15.6	0.0	1.99	.08	1.24	Pronounced.	Faint.	Pronounced.
3236	Ostrich ranch	1 N.	1 E.	3	Feb. 16, 1904	170	130.0	76.0	8.2	0.00	.....	.....	Very strong.	Distinct.	Strong.
3230	Bartlett-Heard	1 N.	4 E.	30	Feb. 4, 1904	100	194.0	126.0	5.44	0.0	0.0	0.0	Strong.	Strong.	Strong.
3237	D. B. Heard	.....	.....	.....	Feb. 16, 1904	.....	185.0	111.6	13.6	0.0	.....	.....	Strong.	Strong.	Very strong.
3238	Bristol Flummerfelt	1 S.	4 E.	11	.....do	61	186.0	122.0	13.6	0.0	.....	.....	Strong.	Strong.	Very strong.
3239	Robert Bowen	2 S.	9 E.	(?)	.....do	212	54.0	24.0	16.3	0.0	.....	.....	Distinct.	Distinct.	Strong.

Analyses of waters from Salt River Valley.[a]

[Parts in 100,000.]

Owner of well.	Location.			Depth of well.	Total salts in solution.	Calcium sulphate.	Calcium and magnesium carbonates.	Chlorine reckoned as common salt.	Sodium carbonate.	Sodium nitrate.	Qualitative.
	Township.	Range.	Section.								
				Feet.							
Phoenix city supply	1 N.	3 E.	4	42	116.8	1.0	22.0	72.0	.....	1.0	Magnesium sulphate.
A. P. McKern	1 N.	3 E.	6	.....	171.46	1.3	32.65	110.0	.....	.06	Magnesium chloride and sulphate.
—— Thomas	.....	.....	.....	30	117.65	1.35	14.60	66.5	.....	.2	Do.
School building	1 N.	3 E.	5	.....	216.10	5.60	23.05	150.0	Trace.	.2	Magnesium sulphate.
Indian School	2 N.	3 E.	20	15	222.0	.....	26.65	141.0	33.36	.....	Sodium, magnesium, and potassium sulphates.
Do	2 N.	3 E.	20	60	362.25	29.95	27.45	258.0	.....	.3	Calcium chloride, magnesium chloride and sulphate.
Well south of W. S. Lawrence's places.	.....	.....	.....	30	413.10	5.45	47.75	285.0	.....	.6	Magnesium chloride and sulphate.
Well at middle one of W. S Lawrence's places	.....	.....	.....	24	370.80	.....	22.15	176.5	23.59	.3	Sodium and potassium sulphates.
—— Cawthorn	2 N.	3 E.	29(?)	65	97.60	1.60	11.35	61.0	.....	.4	Sodium and magnesium sulphates.
—— Blaine	2 N.	3 E.	4(?)	105	44.90	1.85	5.35	16.0	.....	.8	Magnesium sulphate.
J. A. Wieder	3 N.	3 E.	32	146	76.1	1.20	15.75	31.5	.....	.7	Calcium chloride, magnesium chloride and sulphate.
—— Beshier	2 N.	3 E.	20(?)	36	126.90	.26	5.05	43.0	39.22	.1	Sodium and potassium sulphates.
—— Churchill	2 N.	3 E.	20(?)	92	284.60	7.15	21.10	103.0	.....	.8	Magnesium sulphate.
M. Morrison	2 N.	3 E.	32(?)	28	287.50	19.30	16.65	203.0	.....	.8	Calcium chloride, magnesium chloride and sulphate.
Col. Wm. Christy	1 N.	2 E.	1	22	150.60	2.65	20.45	84.0	.....	.05	Magnesium sulphate.
G. R. Brewster	2 N.	2 E.	36	35	122.46	.21	10.60	44.5	33.63	.4	Sodium and potassium sulphates.
Blacksmith shop	2 N.	2 E.	26	50	116.30	.22	9.15	56.0	34.13	.05	Do.
A. H. Smith	2 N.	2 E.	21	95	130.50	6.8	11.65	40.0	.....	10.0	Calcium chloride, magnesium chloride and sulphate.
Frank Alkire	2 N.	2 E.	21	96	41.10	2.2	8.7	10.0	.....	1.5	Magnesium chloride and sulphate.
—— Barclay	2 N.	2 E.	17	90	340.80	56.90	12.25	68.0	.....	16.0	Do.

[a] McClatchie, Alfred J., and Forbes, Robert H., Ariz. Agric. Exp. Station, Bull. 30, 1899.

Analyses of water from Salt River Valley—Continued.

Owner of well.	Location.			Depth of well.	Total salts in solution.	Calcium sulphate.	Calcium and magnesium carbonates.	Chlorine reckoned as common salt.	Sodium carbonate.	Sodium nitrate.	Qualitative.
	Township.	Range.	Section.								
				Feet.							
—— Boyer	2 N.	2 E.	18(?)	80	234.45	21.30	10.85	149.0	.....	0.6	Calcium and magnesium chlorides.
W. S. McClain	2 N.	2 E.	18	80	117.55	1.2	11.75	29.0	.....	7.0	Sodium and magnesium sulphates.
Glendale town well	2 N.	2 E.	5	90	79.2	2.8	20.0	39.0	.....	.....	Sodium sulphate, magnesium chloride and sulphate.
—— Bartlett	3 N.	2 E.	30	140	53.05	2.0	6.95	17.0	.....	.8	Magnesium chloride and sulphate.
—— Mosher	2 N.	1 E.	9	70	346.40	111.50	13.85	112.0	.....	1.0	Sodium and magnesium sulphates.
J. B. Morgan	2 N.	1 E.	5	40	46.20	1.45	15.75	10.0	.....	.4	Do.
H. L. Underhill	2 N.	4 E.	22	61	84.4	1.55	12.80	50.0	.....	.15	Magnesium chloride and sulphate.
George Blount	2 N.	4 E.	26	40	159.35	20.90	22.40	90.0	.....	.4	Sodium and magnesium sulphates.
Arizona Falls canal water, taken Sept. 17, 1898.	.....	.....	.....	.....	93.30	1.0	13.60	61.5	.....	.....	Do.
Arizona Falls water taken Jan. 5 to Jan. 31, 1897.	.....	.....	.....	.....	46.4	.....	16.3	17.0	.....	.....	
F. A. Hough	1 N.	4 E.	23	22	103.03	.9	16.35	67.0	.....	.....	Magnesium chloride and sulphate.
J. W. Woolf	1 N.	4 E.	23	15	159.96	1.90	32.90	94.0	.....	.2	Magnesium sulphate.
J. B. Mullen	1 N.	4 E.	35	13	287.56	4.0	40.45	192.0	.....	.25	Magnesium chloride and sulphate.
W. T. Trusler	1 N.	4 E.	27	12	163.10	.43	12.0	88.5	26.82	.3	Sodium and potassium sulphates.
Nels Peterson	1 N.	4 E.	29	20	221.80	.66	15.30	141.5	24.91	.2	Do.
Canaigre ranch, 6 miles southeast of Phoenix.	.....	.....	.....	34	171.40	1.60	29.05	108.5	.....	.2	Magnesium chloride and sulphate.

Analyses of waters in Salt River Valley by electrical method.

[Data furnished by Thos. H. Means.]

Source of sample.	Location.	Depth to water.	Parts of Na_2CO_3 in 100,000.	Parts of solids in 100,000.
		Feet.		
Tempe ditch ..	1 mile south of Tempe			105
Jenkins ditch .	¾ mile east of Bell Butte			209
Do	do		5.8	195
Do	do			211
Well	Sec. 33, T. 1 N., R. 4 E., just below canal			258
Canal	do			115
Well	Sec. 3, T. 1 S., R. 4 E., ¼ mile south of date orchard			251
Do	Sec. 27, T. 1 S., R. 4 E., Harmon's place	5	10.5	160
Do	Sec. 19, T. 1 N., R. 4 E., Reed's place	16		265
Do	Sec. 27, NE. ¼ NE. ¼, T. 1 N., R. 4 E., Rice place	9		209
Do	Sec. 35, SE. ¼ SW ¼, T. 1 S., R. 4 E	(a)		167
Canal	do			111
Well	Sec. 24, SE. ¼ SW. ¼, T. 1 N., R. 5 E	11		179
Do	Sec. 19, NE. ¼ SE. ¼, T. 1 N., R. 5 E	30		161
Do	Sec. 2, NW. corner, T. 1 S., R. 5 E	15		213
Canal	Sec. 36, T. 1 N., R. 5 E., Consolidated canal			99
Well	Sec. 12, NE. corner, T. 1 S., R. 5 E	50		436
Do	Pumping plant below Highland canal, east of Mesa	60		92
Springs	Sec. 13, T. 1 N., R. 4 E., springs along Salt River seeping from gravel.			167
Salt River	Sec. 13, T. 1 N., R. 4 E			152
Do	At Tempe Bridge			123
Well	Sec. 13, NE. ¼ NW. ¼, T. 1 N., R. 4 E	12		189
Salt River	Above intake of Tempe canal			113
Well	Sec. 9, SW. ¼ SW. ¼, T. 1 N., R. 4 E	13		158
Ditch	Sec. 23, T. 1 N., R. 3 E., south side			150
Salt River	Southwest of Phoenix			135
Well	Sec. 6, SW. corner, T. 1 S., R. 6 E	40		184
Do	Sec. 9, SW. ¼ SW. ¼, T. 1 N., R. 3 E., brickyard	12		179
Salt River	Sec. 19, SW. corner, T. 1 N., R. 2 E			131
Canal	St. Johns canal, meridian line			144
Well	Sec. 9, T. 1 N., R. 3 E., south of S. P. depot			177
Do	T. 1 N., R. 1 E			305
Do	Sec. 13, NW. ¼ SW. ¼, T. 1 N., R. 1 E			277
Draw	Emptying into Gila River 2 miles above Agua Fria			258
Gila River	At initial monument			169
Canal	St. Johns canal			159
Well	¾ mile north of initial monument			213
Gila River	¼ mile west of initial monument			158

[a] Rises to surface.

ORIGIN OF SALTS.

SALTS IN WELL WATER.

An inspection of the chemical analyses of well waters and a comparison of them with analyses of the river water given below reveals a remarkable similarity in the salt content. Since the débris contributed by Salt River is the principal source of the valley fill, we naturally look to Salt River as the source of the salts found in the sediment. The accompanying table by Professor Forbes[a] indicates the character

[a] Forbes, R. H., The river irrigating waters of Arizona: University of Arizona Agric. Exp. Sta. Bull. No. 44, 1902, p. 174.

of Salt River water. The salts of the valley fill are regarded as concentrations by evaporation from the river waters. A study of the conditions as they exist in and near the river bed at the present time throws some light upon the manner of concentration.

Composition of the waters of Salt River.

[Samples taken at the Consolidated Canal Company's office, Mesa, Ariz., representing the Arizona Canal dam supply.]

PARTIAL ANALYSES.

	High and low summer waters (average of 4 weekly composites of samples taken daily, Aug. 1–Sept. 1, 1899).	Summer flood water (one weekly composite of daily samples taken Sept. 2–9, 1899).	High and low summer waters (average of 4 weekly composites of daily samples taken Sept. 10–Oct. 9, 1899).	Winter flood water (one composite of daily samples taken Oct. 10–17, 1899).	Low winter water (average of 10 weekly composites of daily samples taken Oct. 18–Dec. 30, 1899).	Low winter water (average of 13 weekly composites of daily samples taken Feb. 17–May 30, 1900).	Very low summer water (average of 8 weekly composites of daily samples taken June 1–Aug. 1, 1900).
Silt, per cent by weight	0.32	0.95	0.096	0.714	0.025	0.024	0.025
Soluble solids, parts in 100,000	72.40	110.00	114.20	95.10	102.64	106.90	139.15
Containing chlorine stated as common salt, NaCl	46.2	52.1	72.9	61.9	67.6	72.2	98.1
Containing alkalinity stated as sodium carbonate, Na_2CO_3	.....	1.80	.....	.....	.....	.....	.....
Containing permanent hardness stated as calcium sulphate, $CaSO_4$	1.59	.....	2.79	2.45	2.12	5.43	13.70
Nitrogen, parts in 1,000,000:							
Total nitrogen in silt and water	6.94	26.7	4.36	12.19	1.96	1.48	1.30
Nitrogen in nitrates	1.32	1.2	1.90	1.52	1.21	.67	.78
Nitrogen in nitrites	Traces nearly always.						

COMPLETE ANALYSES OF SOLUBLE SALTS, STATED BY IONS.

[Parts in 100,000 of water.]

Sodium, Na	12.2	18.3	27.45	.....	30.99	32.7	40.73
Potassium, K	1.29	1.41	1.09	.....	1.53	1.23	1.12
Calcium, Ca	6.79	10.2	7.24	.....	4.02	4.37	6.51
Magnesium, Mg	1.74	2.33	2.79	.....	2.84	2.92	3.28
Chlorine, Cl	27.99	31.57	44.11	.....	40.96	43.75	59.44
Sulphuric, SO_4	9.79	4.81	7.27	.....	7.48	7.64	9.19
Carbonic, CO_3	.....	15.45	8.02	.....	11.71	11.51	13.15
Silicic, SiO_3	2.06	1.11	5.83	.....	4.65	5.29	3.55

COMPLETE ANALYSES OF SOLUBLE SALTS CALCULATED TO COMPOUNDS.

[Parts in 100,000 of water.]

Sodium silicate, Na_2SiO_3	3.31	1.79	9.35	.....	7.46	8.50	5.69
Sodium chloride, NaCl	27.84	42.80	60.84	.....	67.54	72.16	98.04
Sodium sulphate, Na_2SO_4	.....	.....	.....	.....	4.97	3.46	.07
Sodium carbonate, Na_2CO_3	.....	1.80	.....	.....	.....	.....	.....
Potassium chloride, KCl	2.45	2.69	2.07	.....	.....	.....	.....
Potassium sulphate, K_2SO_4	.....	.....	.....	.....	3.40	2.74	2.50
Magnesium chloride, $MgCl_2$	6.88	5.81	8.34	.....	.....	.....	.....
Magnesium carbonate, $MgCO_3$	.....	3.03	2.37	.....	9.93	10.21	11.49
Calcium chloride, $CaCl_2$	7.50	.....	.....	.....	.....	.....	.....
Calcium sulphate, $CaSO_4$	13.87	6.82	10.30	.....	3.18	5.37	11.00
Calcium carbonate, $CaCO_3$	.....	20.48	10.53	.....	7.71	7.00	8.20

In certain localities along the river the surface of the underground water is so near the land surface that evaporation takes place readily. Water from the river directly or from the underflow is continually finding its way into these localities, bearing its burden of soluble salts, and escaping from the surface by evaporation, leaving its load of salts behind. Localities which have been thus affected are found near Tempe (Pl. XXIII, *A*) and in many places in Gila Valley. Floods may remove these deposits of salt or may bury them, according to circumstances. At the present time both results are being accomplished. The constant shifting of the river channel causes a corresponding shifting of degradational and aggradational localities. Where the aggradational processes predominate, a notable amount of the accumulated salts are necessarily buried.

SALTS IN RIVER WATER.

The origin of the salts contained in the river water presents a different problem. It has recently been demonstrated by M. O. Leighton and his assistant, Sheldon Baker,[a] of the United States Geological Survey, that the common salt so abundant in Salt River is probably due to large salt springs. Several springs were found along the upper reaches of Salt River whose water is described as a weak brine. The water is also strong in carbonates, as evidenced by large travertine deposits at the point of issuance. Iron is also abundant in the water and is deposited near the springs as red oxide. The carbonates contained in the waters are probably due in part to the limestones drained by Salt River and its tributaries and in part to the decomposition of the granitic rocks in its basin. The sodium carbonate, or "black alkali," seems to be due to the decomposition of the igneous rocks. It will be noted that the river water is ordinarily lacking in black alkali, but that it is contained occasionally in flood waters. It is the belief that this is due to the fall of rain upon some alkali-charged slope or mesa which is seldom visited by rains in sufficient quantity to carry away the soluble salts. Specific examples are given by Professor Forbes[b] as follows:

For the period from September 2 to 17, during which a flood occurred, the salts were greater than in the low water preceding and following. The alkali in this water was also distinctly black in character. These circumstances indicate that this flood, which was due to heavy rainfall on the lower half of the Verde River, washed large surface accumulations of salts from a black-alkaline district into the drainage. To a less degree the same holds true of the small flood from August 16 to 22. In most instances, however, during flood time the soluble salts more or less abruptly decrease oppositely to increasing sediments. Mountain rainfall such as was that of August and October, 1899, and May, 1900, is evidently responsible for this freshening of the water. Mountain rainfall in southern Arizona is more abundant than upon the level, lower deserts. The higher watersheds, being better drained, afford

[a] Personal communication.

[b] Forbes, R. H., op. cit, p. 165.

fresher water. The less frequent, though often copious, floods which sweep the lower levels carry much accumulated soluble salt into the drainage, which is often thus rendered strongly saline.

EFFECT OF SALTS ON VEGETATION.

EFFECT IN ARIZONA.

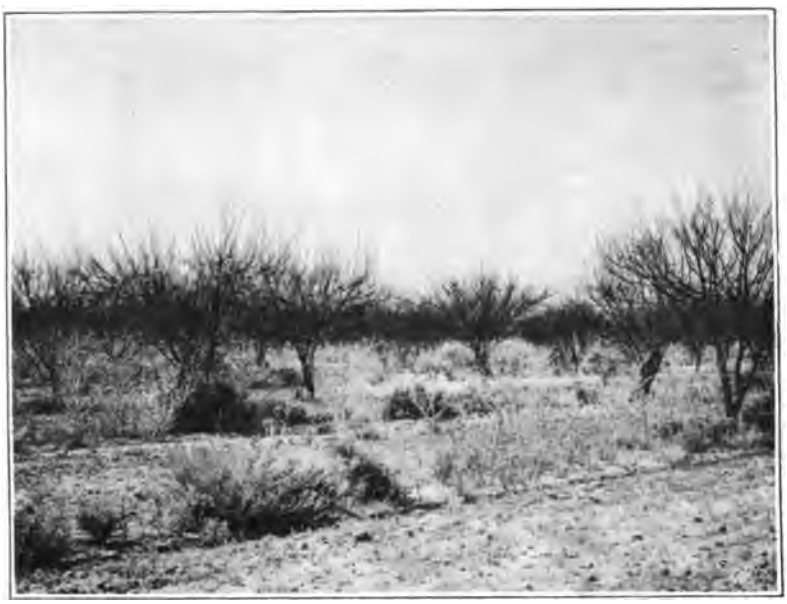
There is a widespread opinion among water users of Salt River Valley that the waters of the underflow are injurious to vegetation. The evidence on this question is conflicting. It is probable that too little is known of determining conditions in Salt River Valley to draw any general conclusion at the present time. The character of the soil, the manner of manipulation, and the kind of crop should be considered as well as the character of the water. Professor Forbes[a] has studied this question and concludes that waters containing more than 100 parts of soluble salts in 100,000 parts of water "are liable in a few years to cause harmful accumulations of alkali."

On the other hand there are many instances of land irrigated with pumped water alone where no detrimental effects can be detected. The Collins well has supplied land entirely with irrigation water containing 150 parts of soluble salts in 100,000 parts of water, for several years, with no detrimental effect that can be detected. Doctor Kunz's garden has had no water for five years other than well water containing 223 parts of salts. The court-house yard in Phoenix has been irrigated for about twenty years with well water alone, containing from 102 to 136 parts of salts. The Indians at the western end of the Pima Reservation have used the seepage water from Salt River, containing about 200 parts of salts, for many years. Land upon which this water has been used continuously at least since the Indians came under the supervision of the white men, about thirty years ago, is at the present time the most productive land on the reservation.

The sodium carbonate (black alkali) is the salt most feared by those who object to the use of pumped water. It will be noted from an inspection of the tables that no sodium carbonate is found in the underflow from which the great proportion of the pumped water is to be secured. The sodium carbonate is found only in the comparatively unimportant surface waters in the Mesa region and in the Phoenix region and is north of the area in which irrigation waters can probably be pumped with profit. It is evident, therefore, that the quantity of this salt which would probably find its way into waters pumped for irrigation is too small to be seriously considered.

The effects of accumulation of salts in the soil is plainly marked in certain parts of the valley. A considerable part of the land south of Tempe is barren in places and covered with white incrustations of salt

[a] Forbes, R. H., op. cit., p. 166.



A. AN ORCHARD NEAR PHOENIX KILLED BY LACK OF WATER.

B. DESERT NEAR TEMPE, SHOWING TYPICAL DESERT VEGETATION.

(Pl. XXIII, *A*). Some of this land has been under cultivation, and has been abandoned on account of the accumulations of alkali. It is in this region that the Bureau of Soils has leased a tract of land for the purpose of demonstrating the methods of reclaiming alkali land.

EFFECT IN EGYPT.

Waters much more saline than those of Salt River Valley may be used for irrigation if used properly, as is shown by the following extract from a circular by Mr. Means:[a]

During the summer of 1902 a representative of the Bureau of Soils visited the oases of the Oued Rihr country in the Desert of Sahara in eastern Algeria. In these oases artesian waters carrying very large quantities of soluble matter are used successfully for irrigation. From the information gathered there, and from experience in this country, it seems that the amount of soluble matter allowable in an irrigation water has been greatly underestimated by American writers, and that many sources of water which have been condemned can be used with safety and success, provided the proper precautions are taken to prevent the accumulation of the salts. As the precautions are those which should be taken by every irrigator, even if pure water is used, it seems an important matter to bring before the American people the methods in use in the Sahara.

The staple crop grown by the Arabs in the oasis country is the date, the fruit of a palm tree known to be one of the plants most resistant to alkaline or saline conditions of the soil, but in addition to this considerable quantities of the deciduous fruits, garden vegetables, and alfalfa are produced for home consumption.

Some of the vegetables successfully grown are those considered sensitive to alkali, and yet they were being irrigated with water containing in some instances as much as 800 parts of soluble salts to 100,000 parts of water, sometimes as high as 50 per cent of the salts being sodium chloride.

The limit of concentration for irrigation water in the United States, even where only the most resistant field crops are to be grown, has been placed by some authorities at 30 parts sodium chloride (common salt) or sodium carbonate (black alkali), and at from 170 to 300 parts of the less harmful salts, per 100,000 of water.

* * * * * * *

The fact that the Arabs in Algerian oases are actually growing sensitive plants by the aid of irrigation waters containing from 400 to 800 parts of soluble salts, in some instances 50 per cent sodium chloride, shows that the Bureau has been on the conservative side in its estimates and should encourage a more hopeful feeling among the people occupying areas where only alkali water is available for irrigation.

The prerequisite to the use of water of high salt content in irrigation is the knowledge that the methods employed are opposed to the teachings of most American writers on the subject. Those who place the low limit of safety for alkaline irrigation waters have taught that where water was badly alkaline irrigation should be sparing. They have not insisted on thorough drainage, and they have warned irrigators against too frequent irrigation. With such practices the limit of concentration which they set is probably high enough, and even then all except the most sandy soils or those with exceptionally good natural drainage would ultimately be damaged.

The methods in the oases are quite different. The Arab gardens are divided into small plats, about 200 feet square, between which run drainage ditches dug to a depth of about 3 feet. The soils being very light and sandy, this ditching at short intervals

[a] Means, T. H., The use of alkaline and saline waters for irrigation: Bur. Soils Circular No. 10, U. S. Dept. Agric., 1903.

insures the most rapid and thorough drainage. Irrigation is by the check method, and application is made at least once a week, though often two wettings a week are deemed necessary. A large quantity of water is used at each irrigation. Thus a continuous movement of the water downward is maintained, and there is little opportunity for the soil water to become more concentrated than the water as applied, and the interval between irrigations being so short but little accumulation of salt from evaporation at the surface takes place. What concentration or accumulation does occur is quickly corrected by the succeeding irrigation.

The native gardens are situated in the date palm groves and the vegetables and fruit are grown in the partial shade cast by these trees. The natives not only have the question of very saline irrigation waters to contend with, but the soils originally are often very alkaline. In three years they reclaim land too salty to grow the minor crops, using the saline water for that purpose, following the same plan of drainage and weekly irrigation as where crops are growing. One garden situated on the side of a salt flat and originally very saline was visited. Here alfalfa was in very good condition, and fig, pomegranate, melon, tomato, cabbage, pepper, and other plants were growing luxuriantly. The reclamation of this plat by irrigation twice a week had taken three years.

* * * * * * *

The irrigation water is all drawn from artesian wells. A number of samples were sent in to the laboratory for analysis, the results of which are shown in the following table. These are fair average samples of the irrigation waters in use, and do not represent by any means the maximum of salinity. Field tests showed as high as 816 parts to 100,000 of water in actual use on soils growing vegetables.

Chemical analyses of artesian water used in irrigating gardens in Sahara oases, Algeria.

Constituent.	Well at oasis Tabesbest.	Well at oasis Kudi Asli.	Well at garden of Ben Hadrian.
Ions:	*Per cent.*	*Per cent.*	*Per cent.*
Calcium (Ca)	9.92	4.19	9.86
Magnesium (Mg)	4.52	6.02	4.26
Sodium (Na)	14.03	20.48	14.18
Potassium (K)	4.27	2.35	2.72
Sulphuric acid (SO_4)	34.38	29.43	17.59
Chlorine (Cl)	28.06	36.21	27.05
Bicarbonic acid (HCO_3)	5.02	1.32	24.34
Conventional combinations:			
Calcium sulphate ($CaSO_4$)	33.04	14.23	24.90
Magnesium sulphate ($MgSO_4$)	13.63	24.29	7.04
Magnesium chloride ($MgCl_2$)	7.23	4.41	16.72
Potassium chloride (KCl)	8.12	4.48	5.19
Sodium bicarbonate ($NaHCO_3$)	6.92	1.81	33.54
Sodium chloride (NaCl)	31.06	50.78	12.61
Total solids in 100,000 parts water	601.50	408.10	571.90

A. SEEPAGE LAND SOUTHEAST OF TEMPE.

B. VIEW SOUTHWARD FROM TEMPE BUTTE.

QUANTITY OF UNDERGROUND WATER.

THE UNDERFLOW.

WATER ENTERING THE VALLEY.

In order to secure a measure of the water entering the valley fill as underflow, it would be necessary to measure all streams, both permanent and intermittent, as well as the occasional waters entering as sheet wash from the surrounding hills. It would be necessary, furthermore, to measure the quantity of surface water escaping from the valley. The greater part of the supply is from Salt River and the total quantity entering from this source is known from the records of the gaging stations on Salt and Verde rivers. The amount taken from the river by the canals is known, but the loss from the valley during times of flood is unknown on account of the want of a gaging station at the outlet of the valley. It is, therefore, obviously impossible to arrive in this way at even an approximate measure of the water entering the underflow. Other methods must be resorted to in order to obtain a quantitative estimate.

RETURN WATER.

The Tempe canal diverts all the surface water of the river north of Mesa. Near Tempe the underground water returns to the surface, making a flow of about 35 second-feet. West of Phoenix the underground water again returns to the surface. It is not possible at present, however, to state what proportion of the seepage water comes from Salt River, since its underflow joins that from Gila River. It is probable, however, as previously stated, that the underflow of the Gila is fed in large measure by the waters from Salt River passing as underflow east of Salt River Mountains. In Gila Valley west of Florence all the waters diverted from the river, except during occasional floods, are seepage waters. The flow in the Gila channel and in the Indian ditches at Gila Crossing was 800 inches when measured on August 17, 1902. Mr. M. M. Murphy estimated the water diverted by the Indian ditches east of the junction of Gila and Salt rivers in January, 1903, as 500 inches, leaving 1,000 inches in the river. The smaller canals of Salt River, between Tempe and the Buckeye, divert water as follows:

Water received by canals west of Phoenix, Ariz.

[Information furnished by M. M. Murphy.]

Canal.	June, 1902.	June, 1903.
	Inches.	*Inches.*
Leon	265	None.
Peninsula	35	234
Lambeye	74	138
Meridian	153	180
Indian	82	72
Total	609	624

The winter flow is about double the above. Available summer flow at the head of St. Johns canal is 400 inches.

Maximum winter flow (not flood) at St. Johns is 800 inches.

Indian ditches on the lower Gila take a minimum of 400 inches.

The amount taken by the Salt River and Maricopa canals—joint head—for June, 1903, averaged 1,344 inches. This is slightly more than usual.

The amount diverted by the Buckeye canal is given by Mr. W. A. Apgar, as follows:

Flow in Buckeye canal.

	Second-feet.
July, 1902	78
July, 1902 [a]	80
May 14, 1903	129
May 23, 1903	133
May 24, 1903	128

Davis[b] says:

The amount of seepage water was measured by Mr. Cyrus C. Babb in June, 1896, and the results showed in one case an increase of over 80 second-feet in a distance of 7 miles.

Code[c] states that "the return flow picked up by the head of the Maricopa and Salt River canals in ordinary years is found to approximate 60 cubic feet per second. This flow has naturally decreased during the past summer owing to the scanty irrigations received by the Mesa, Utah, and Tempe lands above, and to the gradual lowering of the underground supply." He states further that—

at the head of the Buckeye canal, some 24 miles farther down the stream, is again found a volume approximating in ordinary summers 150 cubic feet per second. * * * Some 20 miles below the Buckeye, I am told, another flow of approximately 50 cubic feet per second is to be picked up.

[a] A few days later.

[b] Davis, A. P., Irrigation near Phoenix, Ariz.: Water-Sup. and Irr. Paper No. 2, U. S. Geol. Survey, 1897, p. 43.

[c] Code, W. H., Irrigation in Salt River Valley, in Report of irrigation investigations for 1900, No. 2: U. S. Dept. Agric., Bull. 104, 1901, p. 103.

According to Code's estimate the return water is 210 second-feet, whereas the estimate given above is only 150.

There is no time for which measurements are available for all the canals diverting seepage water. The amount, however, of the seepage water does not vary to any great extent. The average amount, then, according to the best measurements and estimates available is something over 150 second-feet, making a total of more than 100,000 acre-feet per year.

If Code's estimate be accepted the return water east of the Buckeye canal is something over 150,000 acre-feet per year. A small part of this is return water from irrigated lands, but the greater part is from the natural underground flow. A considerable but undetermined part of it is from the Gila underflow, but the greater part is from Salt River.

The seepage waters estimated at 100,000 acre-feet per year are only those returning to the surface east of the Buckeye canal, and take no account of a large quantity of return water diverted by the several canals farther down the river. Furthermore no account is taken of the quantity passing as underflow through the gravels at the lower end of the valley, at the Buckeye head-gates. The 100,000 acre-feet is a measure of the spill from the top of the underflow—water which the valley fill for some reason is unable to hold. The total volume of underflow is therefore something greater than 100,000 acre-feet per year.

MEASURING THE UNDERFLOW.

SLICHTER'S METHOD.

The most elaborate and scientific method of arriving at a quantitative estimate of the underground waters of the valley is obtained from the application of Slichter's[a] method. On account of the great importance of arriving at as accurate an understanding as possible of the underflow and its probable volume, I quote from this paper such portions as apply to the principles and methods of procedure. After a discussion of the principles relating to the movement of underground waters, Professor Slichter proceeds:

Formula.—The formula which the writer has devised for determining the flow of water through a column of sand is as follows:

$$q = 0.2012 \frac{pd^2s}{\mu hK} \text{ cubic feet per minute.} \qquad (3)$$

In this formula q stands for the quantity of water transmitted by the column of sand in one minute; p is the difference in pressure at the ends of the columns, or the head under which the flow takes place, measured in feet of water; s is the area of the cross section of the sand column, measured in square feet; h is the length of

[a] Slichter, Charles S., The motions of underground waters: Water-Sup. and Irr. Paper No. 67, U. S. Geol. Survey, 1902, pp. 24-30.

the column, in feet; d is the mean diameter of the soil grains, measured in millimeters, or the so-called "effective size;" μ is the number which takes account of the friction between the particles of water, and is known as the coefficient of viscosity it is defined as the amount of force necessary to maintain unit difference in velocity between two layers of water unit distance apart; its value, which decreases rapidly with an increase in the temperature of water, for temperatures from 32° to 100° is given in the table below); K is a constant which depends upon the porosity of the sand, and its value for porosities, varying from 26 to 47 per cent, has been computed and is given in the table, page 155.

Variations of the viscosity of water with temperature, and the relative flow[a] of water of various temperatures through a soil, 50° F. being taken as the standard temperature

Temperature.	Coefficient of viscosity μ.	Relative flow.[a]
°F.		
32	0.0178	0.74
35	.0168	.78
40	.0154	.85
45	.0142	.92
50	.0131	1.00
55	.0121	1.08
60	.0113	1.16
65	.0105	1.25
70	.0098	1.34
75	.0092	1.42
80	.0087	1.51
85	.0081	1.62
90	.0077	1.70
95	.0073	1.80
100	.0069	1.90

[a] "Relative flow" means flow at a given temperature compared with flow at 50° F. It is expressed as a percentage.

Constants for various porosities of an ideal soil.

Porosity m.	$\frac{1}{K^2}$	Log. K.	Diff.	Colog. K.
Per cent.				
0.26	0.01187	1.9258	563	8.0742
.27	.01350	1.8695	504	8.1305
.28	.01517	1.8191	490	8.1809
.29	.01694	1.7701	502	8.2299
.30	.01905	1.7199	467	8.2801
.31	.02122	1.6732	455	8.3268
.32	.02356	1.6277	430	8.3723
.33	.02601	1.5847	438	8.4152
.34	.02878	1.5409	410	8.4591
.35	.03163	1.4999	407	8.5001
.36	.03473	1.4592	400	8.5408
.37	.03808	1.4193	377	8.5807
.38	.04154	1.3816	371	8.6184
.39	.04524	1.3445	367	8.6555
.40	.04922	1.3078	353	8.6922
.41	.05339	1.2725	351	8.7275
.42	.05789	1.2374	345	8.7626
.43	.06267	1.2029	339	8.7971
.44	.06776	1.1690	320	8.8310
.45	.07295	1.1370	312	8.8630
.46	.07838	1.1058	329	8.8942
.47	.08455	1.0729	.....	8.9271

If t stands for temperature of the water F., the author's formula, in which the coefficient of viscosity has been replaced by an expression varying with the temperature similar to that given in the formula of Hazen, may be written as follows:

$$q=11.3\,\frac{pd^2s}{hK}\,[1+0.0187\,(t-32)]\text{ cubic feet per minute.} \qquad (4)$$

It is seen from the above formula that the quantity of water transmitted by a column of sand not only depends upon the length of the column and the head of water as expressed by Darcy's law, but varies in a most remarkable way with the effective size of the soil grain, with the temperature of the water, and with the porosity. Since the flow varies as the square of the size of the soil grain, this element in the formula has a most important effect, as doubling the size of the soil grain will quadruple the flow of water. Thus the flow through a sand whose effective size of grain is 1 mm. is 10,000 times the flow through a soil whose effective size of grain is 0.01 mm. The variation of flow with temperature is also important, as the flow at 70° F. is about double that at 32° F. The variation in porosity is quite as important as the variation in temperature.

From the table on page 155 it appears that if two samples of the same sand are packed, one sample so that its porosity is 26 per cent and the other sample so that its porosity is 47 per cent, the flow through the latter sample will be more than seven times the flow through the former sample. If the two samples of the same sand are packed so that their porosities are 30 per cent and 40 per cent, the flow through the latter sample will be about 2.6 times the flow through the former sample. These facts should make clear the enormous influence of porosity on flow, and the inadequacy of a formula of flow which does not take it into account.

Part of the expression on the right side of formula (3) or (4) depends only upon the character of the soil through which the water is passing. Representing this by k, we have

$$k=0.2012\,\frac{d^2}{\mu K}=Md^2 \qquad (5)$$

and the formula for the flow becomes

$$q=k\frac{ps}{h}, \qquad (6)$$

which is essentially Darcy's formula. The constant k is the quantity of water that is transmitted in unit time through a cylinder of the soil of unit length and unit cross section under unit difference in head at the ends. We shall frequently refer to k as the transmission constant, or merely as the constant of a soil.

Rates of flow.—It should be especially noted that the velocity of flow through a soil for the pressure gradients and size of grain that commonly occur is exceedingly slow, and much less than might at first be supposed. Darton states that the rate of flow in the sands of the Dakota formation, from which the remarkable artesian wells of South Dakota draw their supply, does not exceed a mile or two a year. Mr. E. L. Rogers reported to the Denver Society of Civil Engineers that American estimates agree with careful and exhaustive studies of French engineers, which show the average velocity in sands to be about a mile a year, or about an eighth of an inch a minute. In Arizona the rate has been figured out as between one-fourth and one-third of an inch per minute, while on Arkansas River above Dodge, Kans., a ditch a mile long and 5 feet below the water table in the sand developed a flow of about three-eighths inch per minute.

Velocity of water in sands of various effective sizes of soil grain and the maximum flow or transmission constant for each soil.

[Porosity, 32 per cent; temperature, 50° F. Results for other porosities can be found by the use of table on page 158, and for other temperatures by the use of table on page 154.]

1. Diameter of soil grain.	2. Velocity, pressure gradient 1:1.	3. Velocity, pressure gradient 1:1.	4. Velocity, pressure gradient 100 feet to 1 mile.	5. Maximum flow, or transmission constant, *k*.	6. Logarithm of numbers in column 5.	7. Kind of soil.
Mm.	*Inches per minute.*	*Miles per year.*	*Miles per year.*	*Cubic feet per minute.*		
0.01	0.0014	0.0113	0.00026	0.000036	5.5569	Silt.
.02	.0054	.0452	.00102	.000144	6.1590	
.03	.0122	.1016	.00230	.000324	6.5111	
.04	.0218	.1807	.00408	.000577	6.7610	
.05	.0340	.2823	.00638	.000901	6.9548	Very fine sand.
.06	.0490	.4065	.00918	.001298	7.1132	
.07	.0667	.5534	.01250	.001766	7.2471	
.08	.0871	.7228	.01633	.002308	7.3621	
.09	.1103	.9147	.02066	.002920	7.4654	
.10	.1361	1.129	.02551	.003605	7.5569	Fine sand.
.12	.1961	1.627	.03674	.005192	7.7153	
.14	.2668	2.213	.05011	.007065	7.8491	
.15	.3063	2.541	.05753	.008112	7.9091	
.16	.3485	2.892	.06382	.009228	7.9651	
.18	.4412	3.659	.08266	.01168	8.0675	
.20	.5446	4.518	.1021	.01442	8.1590	
.25	.8509	7.058	.1594	.02253	8.3528	Medium sand.
.30	1.225	10.16	.2296	.03244	8.5111	
.35	1.668	13.84	.3125	.04417	8.6451	
.40	2.178	18.07	.4081	.05768	8.7610	
.45	2.757	22.87	.5165	.07300	8.8633	
.50	3.403	28.23	.6377	.09012	8.9548	Coarse sand.
.55	4.119	34.17	.7718	.1090	9.0377	
.60	4.901	40.65	.9183	.1298	9.1132	
.65	5.751	47.81	1.077	.1523	9.1827	
.70	6.671	55.34	1.250	.1766	9.2471	
.75	7.660	63.53	1.435	.2028	9.3071	
.80	8.714	72.28	1.633	.2308	9.3631	
.85	9.835	81.57	1.843	.2604	9.4157	
.90	11.03	91.47	2.066	.2920	9.4654	
.95	12.28	101.9	2.302	.3253	9.5123	
1.00	13.61	112.9	2.551	.3605	9.5569	Fine gravel.
2.00	54.46	451.8	10.21	1.442	.1590	
3.00	122.5	1,016	22.96	3.244	.5111	
4.00	217.8	1,807	40.81	5.768	.7610	
5.00	340.3	2,823	63.77	9.012	.9548	

The table on page [157] gives the velocity of movement of water in sands of various grades for different pressure gradients. Column 1 gives the effective size of the soil grains in millimeters. As already stated, this size is such that if all grains were of that diameter the soil would have the same transmission capacity that it actually has; column 2 gives the velocity of flow, or the rate at which the water moves through the ground in inches per minute under a pressure gradient of 1 foot difference in head to each foot of distance; column 3 gives the velocity of flow reduced to miles per year, the pressure gradient being the same as in column 2; column 4 gives the velocity of flow in miles per year under a pressure gradient of 100 feet to the mile. The velocity for a pressure gradient of 10 feet to the mile would be one-tenth of the numbers in this (fourth) column, and so on for other gradients; column 5 gives the actual discharge in cubic feet per minute for each square foot of cross section if the pressure gradient be 1 foot difference in head in each foot of distance. For the pressure gradient of 1 foot difference in head for each 100 feet in distance the flow per square foot will be 0.01 of the tabulated numbers, and so on for other gradients. The numbers in this (fifth) column have also been called the "transmission constants," and have been represented in the formulas by k.

Relative flow of water through sands of same effective size grain, but packed so as to possess different porosities.

Porosity, or per cent of voids.	Relative flow.
30	0.81
32	1.00
34	1.22
36	1.47
38	1.76
40	2.09

Maximum flow.—Inasmuch as the flow of ground water is nearly always caused by a difference in head due to gravity only, the maximum flow that is possible is found

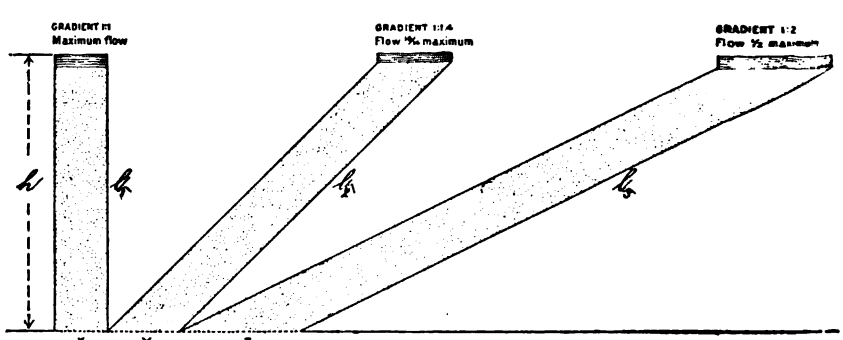


FIG. 22 (7 of Slichter).—Diagram illustrating various pressure gradients and the maximum flow. In these three cases the upper portions of the soil columns are supposed to be supplied with water as fast as it can flow through the columns. The escape at X, Y, Z is supposed to be perfectly free. The head under which the flow takes place is h in each case, as shown at the left of the figure. The various lengths of the soil columns, l_1, l_2, and l_3 produce the pressure gradients $h/l_1=1$; $h/l_2=\frac{1}{1.4}$; and $h/l_3=\frac{1}{2}$, respectively, with the resulting flows in proportion if the material in the various columns be the same.

in the case in which the ground water is free to move in a vertical direction, as in a perfectly underdrained sand-filter bed. The motion in this case is due to the weight of the water of saturation, and the flow is, of course, greater than would be the case if the water were obliged to flow in a direction inclined to the vertical instead of in the vertical direction, as supposed. These facts are illustrated in fig. 22. The flow in the case of pressure gradient 1:1 forms a most convenient basis for calculation, and it is frequently called, as suggested by Hazen, the maximum flow. The flow for any other gradient is immediately calculable from the maximum flow—for a gradient 1:100 the flow being, of course, one one-hundredth of the maximum flow.

The appropriateness of the term maximum flow is illustrated by fig. 23, which shows the original water table and the depressed water table due to the construction of a drainage ditch. It is plain that the pressure gradient for all of the streams of flow marked by arrowheads is less than the gradient 1:1. If the wetted area of the ditch be multiplied by the maximum flow for the kind of material in which the ditch has been excavated, the flow thus computed will in every case exceed the flow actually determined by measurements of the yield of the ditch.

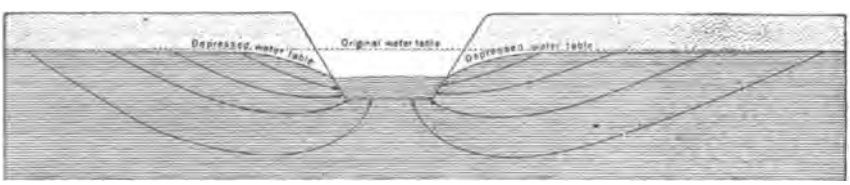


FIG. 23 (8 of Slichter).—Diagram showing lines of flow into a drainage ditch and the shape of the water table in its neighborhood. The head under which the flow takes place is the difference in height of the original water table and the level of the surface of the water in the ditch. This is much less than the lengths of the curved lines of the flow into the ditch, hence the rate of flow must be much less than the so-called maximum flow.

Velocity of flow.—There is not uniformity in the use of the term velocity as applied to the motion of ground waters. We use the term to express the rate (measured as so many feet a day, etc.) at which the water advances through the porous medium, irrespective of the amount of water thus advancing. The amount of ground water (measured in cubic feet per minute, etc.) passing through a given cross section the writer has called the flow or the discharge. It is equal to the velocity multiplied by the porosity. Some measure velocity as a rate of motion in a solid column of same area as the cross section of the porous medium. This is the same magnitude which we have called flow.

In using the table on page 157 one should use the numbers in columns 2, 3, or 4 if the velocity of ground water is wanted, but should pass to column 5 if the flow or yield is required. Thus, suppose it is desired to find the rate of motion of ground water through a bed of sand which slopes 10 feet to the mile: The results can be found for various materials and grades of material by dividing the numbers in column 4 by 10, since a slope of 10 feet to a mile will cause but one-tenth of the velocity existing for a slope of 100 feet to a mile. For materials of various grades we obtain the following results:

Velocity of ground water in materials of different grades, pressure gradient 10 feet per mile.

Material.	Miles per year.	Feet per year.
Fine sand, 0.2 mm. diameter	0.010	52.8
Medium sand, 0.4 mm. diameter	.041	216.0
Coarse sand, 0.8 mm. diameter	.16	845.0
Fine gravel, 2 mm. diameter	1.02	5,368.0

Example.—Suppose that it is desired to ascertain the amount of water that will pass through a bed 200 feet deep and 1,000 feet wide, having the same slope as that just mentioned. This problem requires us to find the flow, and the numbers used in the computation should therefore be taken from column 5 of table on page 157. The flow for one square foot of cross section of the bed will be $\frac{19}{520}$ of the maximum flow given in that column for material of various grades, and the total flow is found by multiplying the maximum flow by $\frac{19}{520} \times 200 \times 1{,}000$, which gives the following results for the same materials described in the preceding table:

Flow of ground water in materials of different grades through a bed of vertical cross section 200 by 1,000 feet, sloping 10 feet per mile.

	Cubic feet per minute
Fine sand	5.5
Medium sand	22.0
Coarse sand	87.0
Fine gravel	546.0

The estimates in the table on page 157 were based upon a porosity of 32 per cent. For other porosities the results must be changed by the percentages shown in the table on page 158. Thus all of the results just found must be increased by about 37 per cent if the porosity of the material be 35 instead of 32 per cent.

FACTORS IN SLICHTER'S METHOD.

In order to apply the principles above quoted it is necessary, in addition to the facts already stated, to know (1) the area of cross section through which the underflow passes; (2) the porosity of the material: and (3) the temperature at the depth at which the flow occurs.

Area of cross section.—On the assumption that the principal source of the underflow is Salt River, and that the underflow passes in part down the present valley past Tempe and in part to the south, east of the Salt River Mountains, it is evident that the open plain between Tempe and the Salt River Mountains and between the Salt River and Sacaton mountains gives a measure of the width of the underflow. Since the principal part of this underflow passes through the bowlder beds and comparatively little through the finer material, the practical width of the underflow is much less than the spaces indicated between the mountains. For all practical purposes the width of the underflow probably does not differ materially from that given in the sections on Pl. XXI, or about 15 miles.

The thickness of the bowlder beds can not be stated with any degree of accuracy, since many of the wells do not reach the bottom of the bowlders. The thickness varies greatly from place to place, but in general is greater near the center of the bed than at the sides, as indicated in the sections just referred to. The wells in the regions near these sections penetrate on the average about 150 feet of gravel and bowlders. Neglecting, then, the finer materials through which a minor quantity of water finds its way, and neglecting the unknown thickness of bowlders which the wells do not penetrate there remains an average

depth of 150 feet across a width of 15 miles, or 11,880,000 square feet, as the working area of cross section of the underflow. The actual area of cross section is greater than this, owing to the unknown thickness of the bowlder beds left out of account, but how much greater is not known. In order to keep well on the side of conservatism the figure is made no larger than known facts warrant.

Temperature.—Since the volume of water passing as underflow varies with the temperature, the temperature of several wells was determined, as follows:

Temperature of wells in Salt River Valley, Arizona, in 1904.

Well.	Location.			Depth.	Temperature.	Time.
	Township.	Range.	Section.			
				Feet.	° *F.*	
Consolidated Canal Co. No. 1	1 S.	5 E.	22	375	84.6	January 19.
Do	1 S.	5 E.	22	150	81.1	Do.
Murphy-McQueen	1 N.	5 E.	34	340	78.1	January 20.
Do	1 N.	5 E.	34	150	77.6	Do.
E. F. Kellner	1 N.	1 E.	6	324	82.3	January 15.
Valley Seedless Grape Co.	1 S.	4 E.	4	319	74.4	December.

With the exception of the Kellner well, the wells in which the temperature was determined are those in active operation. The lowest horizons at which readings were obtained are below the bottom of the bowlder bed. In two wells readings were taken at a depth of 150 feet. The temperature at this depth is the temperature of the water of the underflow, since at that depth the thermometer was in the midst of the bowlder bed.

An inspection of the table indicates a considerable diversity of temperature. In the case of wells in which readings were taken at more than one depth the downward increase in temperature differs materially. In the Consolidated Canal Company well an increase downward is shown of 3.5° F. in 250 feet, while in the Murphy-McQueen well an increase of only 0.5° F. occurred in 190 feet. It is probable that the circulation of the underground water causes the differences in the temperature. Since the waters of the underflow follow the paths of least resistance, a certain quantity of water may be near the surface at one point and in the course of its journey be far beneath the surface at another point. This circulation of the water tends to destroy the regularity in the increase of temperature downward which might otherwise obtain. Variations such as those indicated above are to be expected.

Since there is no uniformity of temperature, the degree chosen to represent the average temperature is a matter of judgment. The average of the temperatures indicated in the table, 79.7° F., is obviously not representative. The Kellner well is not in the direct underflow, so far as known, and the vineyard well, while near the edge of the bowlder bed, is principally in fine material, and the freedom of its connection with the main underflow is a matter of doubt. The two wells from which the first four readings given above were obtained are in the midst of the underflow and are among the most representative wells of the valley. The average of these four readings, 80.3° F., probably represents with some accuracy the average temperature of the underflow. Eighty degrees has, therefore, been chosen as the value of t for substitution in Slichter's formula.

Porosity.—According to the principles laid down by Slichter, the velocity of flow depends upon porosity, and this in turn upon the size of grain. The size of grain is determined as follows:[a]

In order to give expression to the variety of sizes present in a sample, Hazen introduces a number known as the uniformity coefficient. To determine this magnitude, first find the size of sand grain which is such that 60 per cent of the material is of smaller grains and 40 per cent of larger grains. This result, when divided by the effective size of soil grain of the entire sample, gives the uniformity coefficient. Thus, if 60 per cent of a sample be finer than 0.62 mm. and 10 per cent be finer than 0.25 mm., the uniformity coefficient is $\frac{0.62}{0.25}$, or 2½. Hazen concludes from his experimental work that the 10 per cent of small grains in a sample of a natural sand or soil has the same influence on the flow water as the 90 per cent of large grains, provided the uniformity coefficient does not exceed 5.

In order to obtain the porosity of the gravels of Salt River Valley through which the underground waters flow, samples were taken at six localities, as follows:

Derivation of gravels sampled for mechanical analyses.

Name.	Location.			Depth.	Remarks.
	Township.	Range.	Section.		
				Feet.	
River bed	1 N.	3 E.	20	.....	South of Phoenix.
Geo. U. Collins	1 N.	2 E.	15	25	Fully half the material was bowlders more than 1 inch in diameter.
One-half mile north of Collins's.	1 N.	2 E.	10	25	
N. P. McCallum	1 N.	2 E.	24	60	Samples taken from sand pump while well was drilling.
D. B. Heard	1 N.	4 E.	30	75	Do.
Murphy-McQueen	1 N.	5 E.	34	34	Samples taken at water level in the open shaft.

[a] Slichter, Charles S., The motions of underground waters: Water-Sup. and Irr. Paper No. 67, U. S. Geol. Survey, 1902, p. 22.

An effort was made to select the samples in such a manner that they would be representative of the material from which the best pumping plants draw their supply. It will be noted that the samples are all from the regions previously indicated as containing the bowlder beds. While only one sample is from the Mesa region, it is probable that the material represents the gravels there as faithfully as it does those of the Phoenix region. The samples are taken directly from the native material, as exposed in the sides of the well, and are thought to represent adequately the best water-bearing material of the valley.

In each case the proportion of material more than 1 inch in diameter is estimated as half the sample. Since bowlders occur 2 feet in maximum diameter it is obvious that no account of them can be taken in a small sample. It is certain that in some cases the proportion of large material is greater than half. Pebbles 1 inch or more in diameter were discarded and the remainder passed through standard sieves of sizes indicated in the following table. The work was done at the assay office of J. Q. A. King, of Phoenix, and the weight of the various sizes of material was accurately determined as indicated below:

Mechanical analyses of the water-bearing material of Salt River Valley.

RIVER GRAVELS.

Sieve marked.	Size of separation of the sieve in millimeters.	Quantity held by each sieve in grams.	Quantity passing each sieve in grams.	Per cent of total weight of grains less than 1 inch in diameter.	Per cent of total weight of entire sample.
.....	[a] 0.158	31.1	.....	.....	.....
120	.152	3.1	31.1	6.3	3.15
100	.182	29.6	34.2	8.9	4.45
80	.235	25.8	63.8	12.8	6.4
60	.320	50.0	89.6	17.9	8.95
50	.390	97.2	139.6	27.9	13.95
40	.460	225.0	236.8	47.3	23.65
20	.930	23.6	461.8	92.6	46.3
10	2.040	3.1	485.4	97.7	48.85
6	3.900	10.4	488.5	97.9	48.95
.....	[b] 3.900	498.9	510.4	.....	52.1
.....	.....	.....	.....	[c] .21	[c] .43

[a] Less than. [b] Larger than. [c] Effective size.

Mechanical analyses of the water-bearing material of Salt River Valley—Continued.

GEORGE U. COLLINS.

Sieve marked.	Size of separation of the sieve, in millimeters.	Quantity held by each sieve, in grams.	Quantity passing each sieve, in grams.	Per cent of total weight of grains less than 1 inch in diameter.	Per cent of total weight of entire sample.
.....	[a] 0.152	20.5	.....	.....	.....
120	.152	.8	20.5	4.1	2.05
100	.182	14.5	21.3	4.2	2.1
80	.235	14.5	35.8	7.2	3.6
60	.320	23.1	50.3	10.6	5.3
50	.390	47.1	73.4	14.7	7.35
40	.460	167.1	120.5	24.1	12.05
20	.930	35.7	287.6	57.5	28.75
10	2.040	17.7	323.3	64.6	32.3
6	3.900	159.5	341.0	68.2	34.1
.....	[b] 3.900	500.5	659.5	.....	65.9
.....	.....	.....	.....	[c] .31	[c] .43

ONE-HALF MILE NORTH OF COLLINS'S.

.....	[a] 0.152	10.5	.....	.....	.....
120	.152	1.0	10.5	2.1	1.05
100	.182	11.3	11.5	2.3	1.15
80	.235	10.7	22.6	4.5	2.25
60	.320	18.6	33.3	6.7	3.35
50	.390	25.7	51.9	13.8	6.9
40	.460	117.5	77.6	15.5	7.75
20	.930	126.5	195.1	39.0	19.50
10	2.040	53.2	321.6	64.5	32.25
6	3.900	124.5	374.8	74.9	37.45
.....	[b] 3.900	499.5	624.5	.....	62.6
.....	.....	.....	.....	[c] .35	[c] .55

[a] Less than. [b] Larger than. [c] Effective size.

Mechanical analyses of the water-bearing material of Salt River Valley—Continued.

N. P. McCALLUM.

Sieve marked.	Size of separation of the sieve, in millimeters.	Quantity held by each sieve, in grams.	Quantity passing each sieve, in grams.	Per cent of total weight of grains less than 1 inch in diameter.	Per cent of total weight of entire sample.
.....	[a] 0.152	21.9	.....	.....	.....
120	.152	1.7	21.9	4.4	2.2
100	.182	12.2	23.6	4.7	2.35
80	.235	14.3	41.8	8.4	4.2
60	.320	24.8	56.1	11.2	5.6
50	.390	49.9	80.9	16.2	8.1
40	.460	220.5	130.8	26.2	13.1
20	.930	66.6	351.3	70.4	35.2
10	2.040	17.6	417.9	81.9	40.95
6	3.900	63.5	435.5	87.2	43.60
.....	[b] 3.900	499.0	563.5	.....	.....
.....	.....	.....	.....	[c] .29	[c] .42

D. B. HEARD.

.....	[c] 0.152	12.4	.....	.....	.....
120	.152	.9	12.4	2.5	1.25
100	.182	9.4	13.3	2.7	1.35
80	.235	7.7	22.7	4.5	2.25
60	.320	13.7	30.4	6.1	3.05
50	.390	21.7	44.1	8.9	4.45
40	.460	106.0	65.8	13.2	6.6
20	.930	80.0	171.8	34.4	17.2
10	2.040	45.5	251.8	50.5	25.1
6	3.900	201.5	297.3	59.6	29.8
.....	[b] 3.900	498.8	701.5	.....	.....
.....	.....	.....	.....	[c] .43	[c] .56

[a] Less than. [b] Larger than. [c] Effective size.

Mechanical analyses of the water-bearing material of Salt River Valley—Continued.

MURPHY-McQUEEN.

Sieve marked.	Size of separation of the sieve, in millimeters.	Quantity held by each sieve, in grams.	Quantity passing each sieve, in grams.	Per cent of total weight of grains less than 1 inch in diameter.	Per cent of total weight of entire sample.
.....	[a] 0.152	32.7	.....	.....	.....
120	.152	1.6	32.7	6.5	3.25
100	.182	20.5	34.3	6.9	3.45
80	.235	12.2	54.8	10.9	5.45
60	.320	26.0	67.0	13.5	6.75
50	.390	42.7	93.0	18.7	9.35
40	.460	138.5	135.7	27.7	13.85
20	.950	61.5	274.2	55.1	27.55
10	2.040	32.25	335.7	67.2	33.6
6	3.900	130.0	367.95	73.9	36.8
.....	[b] 3.900	497.95	532.25	.....	53.3
.....	.....	.....	.....	[c] .26	[c] .42

[a] Less than. [b] Larger than. [c] Effective size.

Following the example given by Slichter, the results of the mechanical analyses were tabulated, and the effective sizes determined for each sample, as shown in the following table:

Effective size[a] *and uniformity coefficients of material from Salt River Valley as determined by Hazen's method.*

	Diameters of effective size of total sample, in millimeters.	Diameters of effective size of material less than 1 inch in diameter, in millimeters.	Uniformity coefficient for material less than 1 inch in diameter.
River gravel	0.43	0.21	2.47
Geo. U. Collins	.43	.31	2.84
One-half mile north of Collins's	.55	.35	4.86
N. P. McCallum	.42	.29	2.31
D. B. Heard	.56	.43	9.3
Murphy-McQueen	.42	.26	4.61
Average	.47	.31	.....

[a] By *effective size* is meant a diameter of grain such that 10 per cent of the sample is less than that size. It is determined by the intersection of the curve and the 10 per cent line. The effective size differs materially according to the choice of material, as indicated in the foregoing tabulation.

An application of Slichter's formula to the underflow of Salt River Valley, using the effective size thus obtained, gives results which are obviously erroneous, since the quantity of underflow thus indicated is notably less than the quantity known to return to the surface and measured as water actually diverted for irrigation purposes.

A sample of the gravels was sent to Professor Slichter and tested in his apparatus. The sample was taken from George U. Collins's well, and probably represents the water-bearing gravels of the valley as well as any single sample can represent them. The quantity of material rejected as too large to handle was about one-half. The finer material was analyzed by Professor Slichter for porosity and effective size. I quote from his letters as follows:

MADISON, WIS., *March 20, 1904.*

* * * * * * *

I have gone over the samples of gravel you sent with the following results:

Porosity: The porosity of the sample of gravels, after carefully tamping them in the aspirator tube, was found to be 40.3 per cent.

Effective size: The fine portion of the sample that will go through a No 8 sieve was used for the determination. Triplicate determinations give for effective size of this portion of the sample 0.716 mm. The effective size of the actual material you sent is slightly greater, but our aspirator tubes are such that I can not safely introduce large pebbles into the instrument. I shall make an actual test with water of the entire sample as soon as I can do so.

Hazen's 10 per cent is worthless for nearly all western gravels. I have never yet found a sample of heterogeneous gravel that will test to correspond with his 10 per cent. The 50 per cent line is frequently about correct, although even this is often far from the true value.

CHAS. S. SLICHTER.

MADISON, WIS., *April 4, 1904.*

About two weeks ago I sent you results of tests of gravels from Collins's well by aspirator method. I inclose herewith further data.

After picking out the larger pebbles I separated the larger particles by standard sieves, and after each sifting determined porosity and effective size of the gravel passing the sieve. The gravels were packed in the cylinder by tamping while poured in place very slowly, and an effort was made to pack as closely as possible. You will note that the porosity changes greatly, and that the removal of the larger grains has a tendency to lower the effective size of the sample, with one or two notable exceptions.

I believe that the larger grains necessarily omitted from the sample probably would increase the effective size if we could use them. You will note that Hazen's 10 per cent is perfectly useless for all of the samples in the table. The 50 per cent line gives a value of grain nearer the true mean.

Gravel from George U. Collins's well, Salt River Valley, Arizona.

No. of sieve.	Per cent of sample held.	Per cent of sample passed.	Porosity of "pass."	Effective size of "pass," in millimeters.	Transmission constant of "pass" at temperature 80° F., in cubic feet per minute.
2	6.6	93.4	38.1	0.727	0.511
8	.....	.....	40.0	.716	.602
10	16.3	83.7	38.6	.63	.400
12	17.4	82.6	40.3	.68	.543
14	19.7	80.3	39.5	.63	.428
16	22.0	78.0	39.7	.63	.440
18	23.6	76.4	39.6	.62	.427
20	25.8	74.2	40.6	.71	.597
30	44.1	55.9	41.0	.56	.382
40	67.8	32.4	40.6	.42	.209

CHAS. S. SLICHTER.

APPLICATION OF SLICHTER'S METHOD.

It will be noted from the contours of the water table that the inclination of the table varies from 5 to 20 feet per mile, the inclination on the average being practically the same as that of the land surface. The gradient is practically 10 feet to the mile where the principal underflow occurs. This figure is therefore used in the following computation.

The porosity, as previously stated, may reasonably be assumed as 40 per cent, the effective size as 0.72 mm., and the temperature as 80° F. In order that the quantity of underflow may be expressed in acre-feet per year, the number of minutes in one year is placed above the line and the number of cubic feet in 1 acre-foot of water beneath the line.

Applying local values, therefore, Slichter's formula becomes:

$$q=\frac{11.3 \times 10 \times .72^2 \times 11880000 \times 525600}{5280 \times 43560 \times 20.318}[1+.0187(80-32)]$$

acre-feet per year.

Solving this equation we have 148,196 acre-feet per year as the quantitative measure of the underflow of Salt River Valley, or a rate of flow of about 1,360 feet per year. In other words, assuming that the values chosen are correct, a quantity of water sufficient to cover 148,196 acres of land 1 foot deep each year enters the gravels of the valley and works its way at the rate of 1,360 feet per year through the valley fill. This is not a measure of the quantity of water in the gravels at any one time, but a measure of the quantity which passes any given cross section of the valley in one year.

COMPARATIVE DATA FROM OTHER REGIONS.

Owing to the great importance of arriving at an estimate as nearly correct as possible of the quantity of underflow it may be profitable to consider it from different standpoints. There are so many unknown factors and so many varying conditions that no quantitative estimate can be final. Such estimates are, however, of illustrative value in giving a measure of possibilities.

Observations have been made on the rate of movement of underground waters at many localities. L. C. Carpenter has published a paper[a] giving the results of his study on the rapidity of underflow, from which the following quotation is taken:

Near Montrose, Colo., the velocity was found to be about 1 mile per year. At Fort Morgan, Colo., 15 feet per day, or a little more than 1 mile per year in soil and sand. On the Hoover ditch the velocity is 3.6 feet per day, or 314 feet per year in sand.

In the paper previously quoted, Professor Slichter gives rates of movement of underground water as follows:

Weldon Valley canal, 1½ miles in five years, or 1,584 feet per year. Larimer County canal, 40 rods in five years, or 132 feet per year. Near Greeley, Colo., 2½ miles in ten years, or 1,320 feet per year. King River, California, 4.8, 4.3, and 16 feet per day, or 1,792, 1,580, and 584 feet per year. Centerville canal, California, 16 feet per day, or 5,840 feet per year. Kingsbury canal, California, 52 feet per day, or 3.6 miles per year. Arkansas River, Kansas, 2½ feet per day, or 913 feet per year. Near Garden, Kans., 12 feet per day, or 4,380 feet per year. Hondo and San Gabriel rivers, California, 3½, 4, 5½, and 7 feet per day, or 1,278, 1,460, 2,008, and 2,555 feet per year.

To the above data may be added the observations mentioned in Chapter I, that the underflow is made evident through the Bowen well by the collection at one side of floating bodies, and that in the Collins well floating blocks of wood indicate a current sufficiently swift to be plainly visible to the observer. This was noted on three different occasions each time after the well had been undisturbed for several days. On each occasion the velocity was practically the same and appeared to be affected by nothing except the normal movement of the underflow.

From the above data it appears that the rate of underflow as measured in several localities varies from a minimum of 132 feet per year to a maximum of 3.6 miles per year. Because of the application to follow, however, it should be noted here that the material through which the water passed at the above rate is, for the most part, soil or comparatively fine sand. In no case described is the material so coarse as that occurring in Salt River Valley.

[a] Carpenter, L. C., Seepage, or return waters, from irrigation: Colo. Agric. Exp. Sta. Bull. No. 33, 1896.

Viewing the problem from another standpoint, there is available for pumping in the gravels at the present time, provided none escape, water in sufficient quantity to cover the 336,000 acres to a depth of 14 feet. This water if applied to 200,000 acres, the estimated area cultivated in Salt River Valley, would supply the entire area, allowing 4 acre-feet of water per acre per year, for nearly 40 years.

It should be stated in this connection that the immense quantity of water contained in the gravels is continually moving down the valley. While the water table remains constant, the inflow at the head and sides of the valley equals the outflow or discharge at the lower end. The total quantity, therefore, should be considered as a reserve rather than an available supply. The quantity entering the underflow represented by the volume of flow is the maximum amount which can be considered as permanently available for pumping. This amount might be withdrawn continuously if the pumps could be arranged in such a manner as to secure the whole flow. Since this is obviously impossible, something less than the normal flow is permanently available for pumping. A greater draft will draw upon the reserve and continued use of the reserve may lower the water table in time to a horizon too deep for pumping.

From the quantity of the reserve it is evident that pumps might be operated for years before the reserve was exhausted, provided the natural escape of the water from the valley could be prevented. But since this escape is great and constant—more than 100,000 acre-feet per year (besides an unknown quantity passing as underflow in the Buckeye region as previously described)—any great quantity of water extracted by pumps would probably cause a material depression of the water table.

The elevation of the surface where the underflow returns in part, west of Phoenix, is about 200 feet lower than at Mesa. Should the inflow cease the surface of underground water must eventually lower to the level of the point where the water escapes. It is the friction due to passage through the sands and gravels retarding the flow, coupled with the supply from the inflow, that maintains the water gradient. When this balance is disturbed, a disturbance of the water table must result. The practical question is: How much of a disturbance in the way of pumping can be made and still have water within pumping distance?

It is evident that, other things equal, an increase of water entering the valley will raise the water table and a decrease will lower it; an increased draft at the lower end of the valley, whether by escape as seepage or by the demand of pumps, will lower the water table; water withdrawn by pumps at any point in the valley will affect the water table, particularly below the pumps and in general over the whole valley, by disturbing the equilibrium established in nature.

A lowering of the water table of several feet has taken place during the past few years. How much of this lowering, if any, is due to the operation of pumps and how much to the scarcity of water during the past few years, owing to the scant rainfall, is not determinable at present.

The underflow, even though the volume be great, should not be considered as inexhaustible. There is a large quantity of water available; a quantity well worth the necessary expense of pumping plants for securing it. But it is fairly certain that a large number of pumps run continuously will cause a permanent lowering of the water table, and pumps established on high ground may find the lift too great for economic operation after a few years.

Probably the most satisfactory way of utilizing the underground water is to withdraw by pumps no more than the normal flow, leaving the gravels saturated as a reserve to be used in times of need and replaced in times of plenty; in other words, to use the water in the valley fill as a reserve supply rather than to exhaust it quickly in the extension of cultivated land, with the consequent loss of property when the water level falls beyond the reach of the pumps.

PRACTICAL POROSITY.

The proportion of voids given for various diameters of sand grains usually assumes a comparatively uniform size of grain. It is obviously erroneous in heterogenous materials to make computations for any selected size or even for an average size. The finer material packs into the interstices of the coarser. It would be entirely possible to have such materials packed in such a manner as to hold very little water. No doubt such cases occur in the valley fill. There is also no doubt that places may be found where coarse material occurs apart from the fine, and also where, although coarse and fine exist together, they are loosely packed and allow a free passage of water.

It is furthermore obvious that since the sands can not be pumped dry, much water might be held by them which is properly a part of the underflow, but which is not available for pumping. In order to arrive at an approximation of the quantity of water available for pumping in the mixed gravels of the valley, a series of measurements were made by filling a barrel with gravel and sand and measuring the quantity of water which could be poured into it, assuming that this quantity would be a fair measure of the quantity that might be withdrawn by pumping. In order to obtain representative material, the measurements were made at a well east of Phoenix (G. W. Smith's), where the material thrown from the well lies undisturbed. The barrel held 46⅝ gallons—measured by a standard graduate. Such material was first selected as seemed to be a fair average of the water-bearing materials observed throughout the valley. It was sand, pebbles, and

bowlders up to 8 inches in diameter. The sand was slightly moist from a shower which fell the day before the measurements were made. The material was carefully packed in the barrel in order to approximate as nearly as possible the natural conditions. Water was then poured slowly into the material until the barrel was full. It was found that 10½ gallons of water could be poured into the barrel, representing 20.5 per cent of the total space. These gravels might easily be packed more closely in nature than they were in the experiment, and the amount of water that could be pumped from them, leaving them damp since all the water could not be withdrawn, would be something less than 20 per cent of the total bulk.

For a second experiment a place was selected where only coarse gravel and bowlders occurred, varying in size from half an inch to 8 inches in diameter. With this material in the barrel, 16⅝ gallons of water were added to fill the barrel, or 35.8 per cent of the total space. In this case, as in the former one, the percentage of voids in nature would be something less, owing to the closer packing of the gravels. The actual quantity of water available for pumping in this case is something less than 35 per cent of the volume.

Volume of water contained in sands and gravels of different porosity 35 feet deep.

[In acre-feet.]

Valley.	Area in acres.	Porosity.					
		15 per cent.	20 per cent.	25 per cent.	30 per cent.	35 per cent.	40 per cent
Salt River	336,000	1,764,000	2,352,000	2,940,000	3,528,000	4,116,000	4,704,000
Gila River	224,000	1,176,000	1,568,000	1,960,000	2,352,000	2,744,000	3,136,000
Total	560,000	2,940,000	3,920,000	4,900,000	5,880,000	6,860,000	7,840,000

It is evident that the estimated volume of the reserve previously stated as 4,704,000 acre-feet is much greater than the volume which could actually be withdrawn by pumping. In order to have something tangible to consider, the preceding table has been so prepared as to show the volumes of water contained in a given volume of sand and gravel with assumed porosities. The area is chosen to include only the land beneath which water is 50 feet or less below the surface, and where the water level might be lowered 35 feet and still be within pumping distance. Since there is a large area beyond the 50-foot contour beneath which water occurs which is left out of account, it is evident the volumes given in the table are smaller than the actual quantity within reach.

The quantitative estimates for Gila Valley are inserted because of the close association of the two valleys.

It is probable that the practical porosity—that is, the percentage of volume consisting of water actually available for pumping—is somewhere between 15 and 30 per cent.

A pumping plant of average capacity, such as those of the Consolidated Canal Company, throws a continuous stream of about 200 inches. If operated without stop, one pump would raise 3,620 acre-feet of water per year. But since there is always more or less stoppage for repairs, etc., it is assumed, for convenience, that one pump will raise about 3,000 acre-feet per year. The number of pumps required to raise the possible volume of underflow are as follows:

Number of pumps required to raise the water[a] of the underflow.

Number of pumps of 3,000 acre-feet per year capacity.	Volume of underflow in acre-feet.
30	148,196
96	287,760
192	575,520
384	1,151,040

[a] For volume, see tables on pp. 170, 174.

If a volume of underflow of 287,760 acre-feet per year be accepted, as previously suggested, it is evident that 96 pumps would lift the entire flow, provided it could all be secured. It is evident, however, that it could not all be secured. A withdrawal of the supply in any large measure must lower the water table, since the escape of the seepage waters below can not be prevented. The withdrawal of the total supply, if that were possible, would cause a lowering of the water table in time to the level of the outlet, a distance of about 200 feet for the Mesa region. Any depression of the water table due to the loss by seepage at the lower end of the valley will in turn depress the water table in the pumping region. It is therefore evident that, with an inflow of 287,760 acre-feet per year, 96 pumps would soon depress the water table beyond easy reach. In other words, in order to maintain conditions such that the underflow may be permanently and regularly useful, the pumps must be limited, under assumed conditions, to a number notably less than 96.

It is impossible at the present time to give more than a rough estimate of the quantity of water now being withdrawn from the underflow. Few of the pumps run continuously and there are many that run only occasionally to secure irrigation water when other sources fail. The most accurate estimate possible at present (summer of 1904) of the water pumped is 4,000 inches. This amount is pumped only during the summer. Should the pumps now in operation be run continuously

at the estimated rate (4,000 inches) they would supply about 54,000 acre-feet of water per year, or more than one-third of the minimum estimated volume of the underflow.

If the reserve be considered as a part of the available supply for pumping, a much greater number of pumps might be operated for some time before the water table was lowered beyond reach. The pumping area described is about 36 miles in length. At the assumed rate of underflow, water entering at the head of the valley above Mesa would require seventy-two years to make the journey to the mouth of the Agua Fria. At this rate of movement water not only to the amount of the inflow but also large quantities of the reserve might be

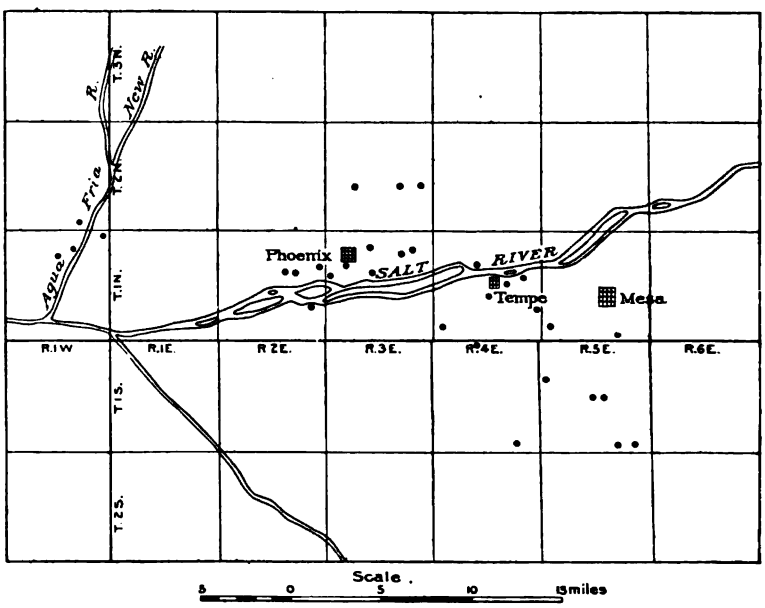


FIG. 24.—Map of Salt River Valley, showing location of pumping plants described.

withdrawn for years before the water table was permanently depressed beyond the limit of lift. Its recovery, however, would be equally slow. If the pumping project is pushed too far, it is inevitable that the more inefficient pumping plants, especially those on higher ground, must be abandoned, owing to increasing lift as the water table is depressed. In this, as in other cases of competition, only the fittest can survive.

If it be objected that the assumed velocity of half a mile per year is too small, and that 1 mile or more per year is the rate of movement, then the volume of flow is correspondingly greater and the number of possible pumping plants will be greatly increased.

COST OF PUMPING WATER.

SALT RIVER VALLEY.

Comparatively little has been known up to the present time of the actual expense of pumping water in Salt River Valley. The pumping tests described in the first chapter and summarized below, deal with conditions as they actually exist. In most cases these conditions are far from ideal. Indeed there are few pumping plants in the valley which are working with the efficiency that could reasonably be expected. There have been no experiments until recently tending to show the most economical method of pumping water, and there is no agreement among those using pumped water as to what kind of pump or what power is best, or even how to construct a well in order that it may give the best permanent results. It is thought that the computations of cost of raising water at the various pumping plants just as they exist with all their imperfections may be of value by way of comparison with guaranteed cost, which is usually based on ideal conditions.

I have excluded from the list all computations except those which I have reason to believe are essentially correct. In some cases certain elements are doubtful; for example, at the Collins well the exact amount of wood used was not obtained. It should be stated also that the test runs upon which the computations are based were short, varying from one to three hours. The figures consequently show the rate irrespective of stoppage for repair or for other cause.

In making the computations I have included in the cost of the acre-foot interest at 7 per cent per annum on the investment, the legal rate of interest in Arizona, and 10 per cent per annum depreciation, the time in each case being the time required for pumping 1 acre-foot of water. No allowance is made for stoppages. In each case the expense for oil and incidentals is estimated at 5 cents per acre-foot.

Records of pumping plants in Salt River Valley, Arizona, on which pumping tests were made.

Name.	Kind of well.	Size.	Total depth.	Depth to water.	Amount of lowering.	Total lift.
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Murphy-McQueen	Drilled	1	1,305	23	19	44
Consolidated Canal Co.:						
No. 2	do	1¼	246	36	15	50.65
No. 3	do	1¼	266	37	11	47.56
Valley Seedless Grape Co	do	1	348	30	11.5	47
Tempe waterworks	do	1	152	23	14	249
T. J. Parry	Dug	40 by 60	21	17	1	18
L. Kunz	do	6 by 6	24	18	(?)	18
Geo. U. Collins	do	60 by 100	29	14	6	22
Nelson & McIlwaine	do	7	26	16	5	21
John Heaton	Dug		12	(?)	(?)	28
	Drilled	½	45			

Records of pumping plants in Salt River Valley, Arizona, on which pumping tests were made—Continued.

Name.	Kind of pump.	Power.	Cost of well and pump.	Capacity per minute.	Cost per acre-foot.	Cost per acre-foot per foot of lift.
				Gallons.		
Murphy-McQueen [a]	Centrifugal.	Steam and wood.	.....	3,038	$2.27 2.97	$0.051 .068
Consolidated Canal Co.:						
No. 2	.....do	Electric	$8,000	2,223	2.84	.066
No. 3	.....do	.....do	8,000	2,273	2.69	.054
Valley Seedless Grape Co	.....do	Gasoline	.....	518	3.80	.08
Tempe waterworks	Triplex	Electric	3,700	275	14.55	.058
T. J. Parry	Bucket	Gasoline	900	673	2.91	.161
L. Kunz	Plunge	Horse	250	62	1.14	.063
Geo. U. Collins	Centrifugal.	Steam and wood.	1,500	2,200	1.93 2.75	.07 .124
Nelson & McIlwaine	.....do	Gasoline	2,200	900	2.88	.157
John Heaton	Plunge	.....do	500	120	3.87	.139

[a] Cost does not include interest and depreciation. If this be added, the total cost becomes approximately $2.97 per acre-foot or 6.8 cents per foot per acre-foot.

It has been estimated that electric power can be furnished at a cost not exceeding $50 per horsepower per year. In three of the pumping plants previously described the horsepower consumed at the pumping station is accurately known. Since these three use electric power, direct comparison can be made as in the following table:

Cost of pumping with power furnished at $50 per horsepower per year compared with present cost.

Name.	Horsepower consumed.	Present cost per acre-foot.	Cost per acre-foot with power at $50 per horsepower per year.	Present cost per acre-foot per foot of lift.	Cost per acre-foot per foot of lift with power at $50 per horsepower per year.
Consolidated Canal Co.:					
No. 2	42.88	$2.84	$0.60	$0.056	$0.012
No. 3	42.88	2.69	.59	.054	.0118
Tempe waterworks	31.51	14.55	3.62	.058	.0144

The experiments upon which these costs are based were performed by Engineer P. E. Fuller, and are thought to be very accurate. For irrigation purposes the first two are most reliable, since they are pumping stations established exclusively for irrigation. No allowance has been made for loss of time for repairs. With such an allowance the price per foot per acre-foot with power at $50 per horsepower per year will be slightly more than 1.2 cents. Owing

to the careful and painstaking experiments of Mr. Fuller this rate can be stated with considerable confidence.

As previously stated, there are places, for example near Tempe, where the water table is less than 10 feet beneath the surface. Allowing a local depression of 15 feet due to the action of the pump, or a total lift of 25 feet, water can be raised for 30 cents per acre-foot, a price much lower than the present cost of canal water.

The actual cost of canal water in Salt River Valley at present is somewhat difficult to estimate, owing to the manner in which water is sold. The price nominally paid is much less than the actual cost, for the quantity nominally paid for is seldom received. It is probable that the actual cost of canal water at the present time is little, if any, below $1 per acre-foot. With a lift of 65 feet, which has been assumed as the present limit, an acre-foot of water would cost 78 cents. The Consolidated Canal Company finds it profitable to pump water at a cost of $2.84 per acre-foot while others are pumping at a cost as high as $3.87 per acre-foot. At the rate of 1.2 cents per foot, water could be raised with profit from a depth much greater than 65 feet, and the pumping area indicated in the map (fig. 21) could be greatly extended.

COST OF PUMPING IN OTHER REGIONS.

It will be instructive to compare the cost of pumping water in Salt River Valley with the cost as determined elsewhere. The following extract contains some data which may be useful:[a]

COST IN ARIZONA, WISCONSIN, AND CALIFORNIA.

The reports of former years and this report have given meager returns from a few pumping plants, showing the cost of raising water. Mr. Code reports the details of tests made by him, and gives as his general conclusion that with wood at $4 per cord water can be lifted 45 feet for $2.50 per acre-foot, and that with power delivered to the pump at $60 per horsepower per annum water can be lifted 45 feet at a cost of $1 per acre-foot. Both these estimates include the cost of attendance and a fair rate of interest on the investment.

Professor King gives the cost of raising water in Wisconsin. At Madison water was raised 25 feet at a cost of $2.64 per acre-foot, using coal which cost $5 per ton. At Stevens Point water was raised 33 feet at a cost of $3.32 per acre-foot, using a gasoline engine, with gasoline at 11.98 cents per gallon.

Professor Chandler gives the cost of an acre-foot of pumped water in the Tule River Valley at from $5 to $7.40, with a lift of 71 feet and power costing $50 per horsepower per annum.

The following table gives all the data regarding the capacities of various kinds and sizes of pumps which have been included in all the bulletins published by this office:

[a] Report of irrigation investigations for 1901, No. 1: U. S. Dept. Agric. Bull. 119, 1902, p. 34.

Capacity of pumps.

Pump.	Power.	Lift.	Capacity per 24 hours.
		Feet.	*Acre-feet.*
2.5-inch Lawrence centrifugal	5-horsepower gasoline		0.264
5-inch Krogh centrifugal	12-horsepower gasoline	30	1.32
Do	do		.99
5.5 by 8 inch triplex-acting pump.	do	125	.594
8-inch centrifugal			8.80
Do			6.60
Do		19	7.26
Do			7.04
Do		14	8.80
Do	18-horsepower engine (burning wood).		4.40
Do		18	7.70
8-inch Krogh		32	6.60
10-inch centrifugal	80-horsepower engine	39	17.60
12-inch centrifugal		23	15.40
16-inch centrifugal	80-horsepower Frick engine	14.5	35.20
18-inch centrifugal			44.00
20-inch centrifugal		15	44.00
Double-cylinder 6-inch pump	4-horsepower gasoline		.396
Triplex pump, 5.5 by 8 inch plungers.	5-horsepower gasoline		.594
Compound duplex pumping engine.	80-horsepower boiler		132.00
Worthington compound duplex steam pumping engine.	do		176.00

COST OF PUMPING IN NEW MEXICO.

An instructive series of experiments has recently been made at the New Mexico Agricultural Experiment Station calculated to show the comparative merits of several makes of pumps. The most economic speed was determined for each make of pump tested, and the cost determined per acre of irrigating 3 inches deep, using wood for fuel at $2.25 per cord. In order that the table may correspond with those previously given, the figures have been altered to read in cost per acre-foot. Otherwise the figures are those given in the various tables by Vernon and Lester,[a] except those in the last column; there the cost is reduced to unit of lift.

[a] Vernon, John J., and Lester, Francis E., Pumping for irrigation from wells: N. Mex. Agric. Exp. Sta. Bull. No. 45, 1903.

Cost of pumping at New Mexico Agricultural Experiment Station.[a]

Name of pump.	Pump running at most economic speed, in gallons per minute.	Cost per acre-foot.	Lift.		Cost per foot of lift per acre-foot.
			Ft.	*in.*	
Van Wie	600	$2.05	27	10¼	$0.073
R. D. Wood	600	2.59	28	½	.092
Kingsford	824	2.39	34	5½	.069
Bryon Jackson	944	2.46	36	8½	.067
Fairbanks-Morse	824	2.47	35	8¾	.069

[a] Fuel is dry tornillo wood at $2.25 per cord.

COST OF PUMPING IN CALIFORNIA.

The principal expense of pumping is the fuel, and the great cost of fuel is responsible for the high rate of cost of pumping in Salt River Valley. In order to compare this with the cost where fuel is inexpensive, I give the following table of costs from pumping plants in California. The data were furnished by Thomas H. Means, of the Bureau of Soils, having been collected by his assistant, W. H. Knox. It appears from these data that water is pumped with crude oil and distillate as fuel, at a minimum cost of less than 1 cent per foot per acre-foot, as compared with a minimum of 8 cents in Salt River Valley, using distillate, and 5.4 cents, using electric power. It appears, also, that with fuel at the price paid in California, water is pumped cheaper than the estimated cost with electric power at $50 per horsepower per year, the minimum being 1.18 cents for electric power and 0.8 cent for crude oil. It should be stated, however, that allowance is made in the California rates for little besides fuel. It is thought that due allowance for interest, depreciation, etc., would bring the rate up to at least the estimated rate for electric power.

Cost of pumping in California.

[Data collected by W. H. Knox, of the Bureau of Soils of the Department of Agriculture.]

Owner.	Location.	Kind of pump used.	Source of supply.	Total lift.
				Feet.
M. T. Ireland	Fowler, Cal	Burton, 4-inch	Pond	15
J. Vincent	do	Krogh, 5-inch	Well	22
J. S. Brander	do	Krogh, 8-inch		20
John Hartly	Fresno, Cal	Richardson, 5-inch	Well	45
J. H. Marsh	Lone Star, Cal	Krogh, 6-inch	do	25
Aug. Ganfraw	Sanger, Cal	do	Slough	36
L. C. Jolley	Del Rey, Cal	Sampson, 6-inch	Pond	15

Cost of pumping in California—Continued.

Owner.	Capacity in acre-feet per hour.	Fuel used.	Cost of fuel per hour.	Cost per acre-foot per foot of lift.	Remarks.
			Cents.	*Cents.*	
M. T. Ireland	0.115	Distillate	6 to 7.5	4.3	
J. Vincent	.10	do	17	7.7	Plant not yet regulated for best results.
J. S. Brander	[a] .75	Crude oil	12.5	.8	Has been operating two years.
John Hartly	.207	Distillate	10	1.1	Distillate costs 10 cents per gallon.
J. H. Marsh	.15	do	6 to 7.5	2	12-horsepower engine—cost of fuel thought to be underrated.
Aug. Ganfraw	.3	Crude oil	[a] 10	.9	
L. C. Jolley	.4	Distillate	11	1.8	

[a] Estimated.

COST OF PUMPING IN EGYPT.

It may be of interest to know the cost of well-established pumping plants abroad. Thomas H. Means, of the Bureau of Soils, who is familiar with irrigation operations in Egypt, has kindly furnished the following information for this paper:

Cost of pumping drainage water at Mex, Egypt.

Season.	Acre-feet pumped.	Price of coal per ton.	Cost per acre-foot per foot of lift.
			Cents.
1895–96	141,750		2.42
1896–97	175,800		2.31
1897–98	187,900		2.36
1898–99	230,800	$6.19	1.87
1899–1900	164,430	8.39	2.87
1900–1901	255,960	8.73	2.79

Equipment consists of five Farcot direct-acting centrifugal pumps and two 48-inch centrifugals, with a total maximum capacity of 1,400 cubic feet per second, though the normal output is not intended to exceed 1,125 cubic feet per second; lift about 10 feet. This is one of the largest pumping plants in the world.

Estimated cost of pumping drainage water at Kassasin, Egypt.—Equipment consists of two 30-inch centrifugals and one 20-inch, run by direct-connected double-expansion engines. Total capacity given as 88 cubic feet per second; expenses of plant about $20,000 per year, making cost of lifting about 4.8 cents per acre-foot per foot of lift.

VALUE OF WATER.

Having ascertained the cost of procuring water by pumping, it is well to know what return can reasonably be expected from its use. Prof. Alfred J. McClatchie, of the Arizona Agricultural Experiment Station, has published a paper dealing with this problem.[a] The following table (Table VI of McClatchie's paper) gives the returns realized from the use of water:

Record of principal crops grown on the farm of the Arizona Experiment Station during 1901.

	Amount of water applied previous to planting.	Date of planting.	Date of first irrigation.	Date of last irrigation.	Number of irrigations.	Depth of water applied during growing of crop.	Total amount applied.
	Feet.					*Feet.*	*Feet.*
Wheat sown in moist soil	0.6	Nov. 26	Mar. 4	Apr. 6	3	1.6	2.2
Wheat sown in dry soil	.....	....do ...	Dec. 8	....do ...	4	2.5	2.5
Wheat sown in moist soil	.6	Dec. 5	Mar. 5	Apr. 11	3	1.5	2.1
Do	.6	Jan. 3	Mar. 7	Apr. 14	3	1.5	2.1
Potatoes	.7	Jan. 9	Mar. 17	May 10	4	1.7	2.4
Do	.7	Feb. 1	Mar. 27	....do ...	3	1.3	2.0
Do	.7	Feb. 22	....do ...	....do ...	3	1.3	2.0
Tomatoes	.6	Feb. 14	Feb. 26	Oct. 28	27	3.7	4.3
Strawberries	.7	Feb. 16	Feb. 16	Dec. 26	36	5.5	6.2
Melons	.7	Mar. 16	Mar. 26	July 8	12	2.6	3.3
Egyptian cotton	.7	Mar. 30	Apr. 11	Oct. 3	13	4.3	5.0
Corn	.6	Aug. 3	Aug. 9	Oct. 7	5	1.5	2.1

[a] McClatchie, Alfred J., Irrigation at the station farm, 1898–1901: Ariz. Agric. Exp. Sta. Bull. No. 41, 1902.

Record of principal crops grown on the farm of the Arizona Experiment Station during 1901—Continued.

	Date of harvesting.	Yield per acre.	Gross value per acre.	Cost of producing and marketing crop per acre.	Net value per acre.	Net return per foot of water applied.
		Pounds.				
Wheat sown in moist soil	May 22	2,150	$22.55	$10.25	$12.30	$5.60
Wheat sown in dry soil	do	1,850	19.40	9.65	9.15	3.65
Wheat sown in moist soil	May 24	2,120	22.25	10.20	12.05	5.74
Do	May 30	1,920	20.15	9.95	10.20	4.85
Potatoes	do	3,200	80.00	35.00	45.00	18.75
Do	May 25	3,600	85.00	34.50	50.50	25.25
Do	May 30	3,000	70.00	34.50	35.50	17.75
Tomatoes	July 1–Dec. 9	12,300	225.00	75.00	150.00	34.90
Strawberries	Apr. 15–July 15	5,000	500.00	150.00	350.00	56.45
Melons	June 15–July 15	27,000	140.00	26.00	114.00	34.55
Egyptian cotton	Dec. 14	400	68.00	48.00	20.00	4.00
Corn	Dec. 10	1,735	18.00	9.50	8.50	4.05

LOCATION OF PUMPING PLANTS.

From the information previously given it appears that the best places for pumping plants are in the region south of Tempe where water is but a few feet beneath the surface and on the lowlands along the river in the Phoenix region. Unfortunately the lands upon which pumped water would be most useful do not lie at a lower elevation than the areas where that water is most easily obtained. The elevation of the land to be irrigated therefore enters as an important factor. In order to flow water over a certain tract of land it frequently happens that pumps must be placed on comparatively high land back from the river. The farther a well is from the axis of the gravel beds—not necessarily coincident with the present river's course—the more likely it is to encounter unfavorable conditions.

The irregular distribution of materials in the valley fill gives rise to many annoying surprises in constructing wells. Certain wells have entirely failed where every known condition promised success. On the other hand, wells have been successful in localities which gave little promise. It is obviously impossible to foresee in more than a general way what conditions are to be met with in sinking wells. The figures which follow are diagrammatic illustrations explaining condi-

tions known to exist in Salt River Valley. In fig. 25 let A and B represent two wells with the water standing 20 feet below the surface in each well. Assume (1) that the material in which they are put down is all water-bearing gravel with one-third of the space occupied by water; it is plain then that a lowering of 30 feet, for example, will yield water represented by one-third of the space *a b h f*—the space in heavy lining. (2) Assume that *a g c* is impervious clay and *a c f* is water bearing; then a lowering of 30 feet in either well would yield water represented by one-third of the space *a i h f*—the shaded portion of No. 2. (3) Assume that *a g c* is gravel and the rest clay; then a lowering of 30 feet in well A will yield water represented by one-

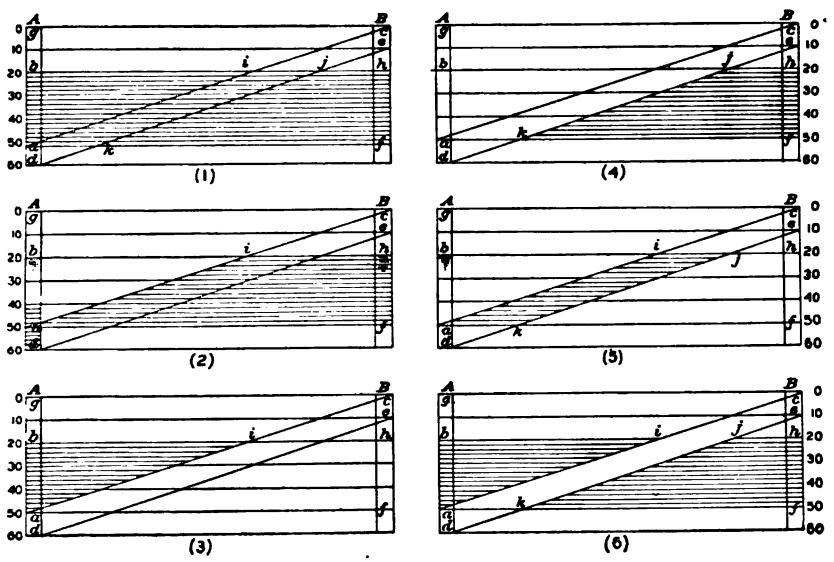


FIG. 25.—Diagrammatic illustrations of underground conditions affecting yield of wells.

third of the space *a b i*, and well B will yield nothing (No. 3). (4) Assume that *d e f* is gravel and the remainder clay; then well A will have no water and well B, in lowering 30 feet, will yield water represented by one-third of the space *k j h f*. (5) Assume that *a c e d* is gravel and the remainder clay; then well B will yield no water and well A only so much as is represented by one-third of the space *a i j k*. (6) Assume that *a c e d* is clay and the remainder gravel; then well A, in lowering 30 feet, will yield water represented by one-third of space *a b i*, while well B will yield water represented by one-third of the space *k j h f*; and the waters may differ in quality as well as quantity.

As a matter of application from the foregoing illustrations it may be stated: (1) That a given set of conditions in one locality will not necessarily be repeated in another, although the two localities are close together; (2) that favorable conditions in one place are not to be interpreted too freely, and, vice versa, that unfavorable conditions in one place are not to be considered entirely discouraging.

RÉSUMÉ.

Some of the more important facts and deductions presented in this paper may be stated as follows:

1. The geological formations which are of most importance in and near Salt River Valley fall naturally in three groups:

(*A*) Pre-Cambrian rocks, consisting of Archean granites and pre-Cambrian quartzites and argillites, in which Salt River Valley was originally formed.

(*B*) Extensive bodies of eruptive rock associated with a limited amount of massive breccia, apparently of Tertiary age.

(*C*) Quaternary and recent formations, consisting of waterworn bowlders, gravel, sand, clay, etc., which partly fill the ancient valley, and are known as the valley fill.

2. The valley fill, at least to a depth of several hundred feet, is regarded as upland or fluviatile accumulation and consists of—

(*A*) River débris, composed principally of waterworn bowlders and gravel of quartzite, quartz, chert, granite, etc.

(*B*) Wash or angular material derived from near-by hillsides.

(*C*) Chemical precipitates, of which caliche is the most important from a geological standpoint. The caliche occurs in more or less impervious layers throughout the valley fill, and serves in many cases to confine the underground water under more or less pressure.

3. The valley fill is not the result of a single period of aggradation. Its accumulation is due to at least two periods of aggradation, perhaps more, separated by a period of degradation.

4. The alternating periods of aggradation and degradation in Salt River Valley correspond with similar periods in other parts of Arizona. Definite correlation of the similar, but widely separated, deposits is impossible at the present time, but uniformity in character and succession over wide areas suggests uniformity of cause.

5. The cause of the accumulation of upland deposits and of the changes from degradational to aggradational condition of streams and vice versa is regarded as due (1) to changes in elevation of the land, and (2) to climatic changes.

6. Salt River Valley is a part of the wide aggraded plain lying southwest of the great continental plateau. Between the plateau and the plain is a mountainous area in which faulting and local crustal movements are numerous. Some of these movements have probably affected Salt River Valley.

7. The isolated peaks and mountain groups in and near Salt River Valley may be due in part to upthrust of crust blocks, but are regarded mainly as remnants of erosion.

8. The plain of which Salt River Valley is a part is due principally to upland accumulations. In the process of accumulation the lowest outlying hills were buried and the higher ones, being only partly buried, are now found rising abruptly from the level plain.

9. The valley fill is saturated with water, and the various beds of gravel are so intimately connected that the water rises to a definite level forming a well-defined water table.

10. During the early part of the accumulation of the valley fill Salt River joined Gila River east of Salt River Mountains, forming in that region the bowlder beds through which the main course of the underflow now finds its way, but at a later stage of the accumulation the river changed to its present course north of Salt River Mountains, forming the uncemented bowlder beds of recent origin, in which the underflow occurs in the Phoenix region.

11. The underground waters are derived mainly from Salt River and to a less extent from the occasional floods entering the valley from the surrounding hills.

12. The valley fill of the Mesa region, to a depth of over 200 feet, consists mainly of river gravels with a subordinate amount of finer material. In the Phoenix region the valley fill consists mainly of fine material with a subordinate amount of river gravels. The river gravels of the Phoenix region occur parallel to the river, and were deposited in a secondary valley, cut in the finer materials of the first period of accumulation.

13. The valley fill is more or less impregnated with various salts derived from the waters of Salt River in former ages and deposited with the detritus.

14. The distribution of the gravel beds and the depth to the water table are such that pumping for irrigation can probably be carried on with profit over an area of 525 square miles.

15. Although some of the underground waters of the valley contain salts in quantities which may be harmful to land under certain conditions, it is probable that with proper manipulation all of the waters can be safely used.

16. The underflow returns in part to the surface in certain places in the valley, making a surface flow estimated as something over 100,000 acre-feet per year.

17. The principal water-bearing horizon is about 15 miles wide in the Mesa region, and extends to a depth of over 200 feet.

18. The quantitative estimate of the underflow, based on experiments, indicates a volume of flow of 148,196 to 287,760 acre-feet per year. At this rate something less than 96 pumping plants of the

average capacity (200 inches) could be operated continuously and retain the water level within pumping distance of the surface.

19. The reserve, or the quantity of water contained in the valley fill at any one time within pumping distance is very much greater than the volume of flow. Conservative estimates place the volume of the reserve of Salt River Valley at from 2,500,000 to 4,000,000 acre-feet.

20. The cost of pumping water in Salt River Valley varies from 5.4 to 13.8 cents per acre-foot per foot of lift, or a cost per acre-foot of pumped water of from $2.50 to something like $5.

21. Since fuel is the great item of cost, the cost could be greatly reduced by the use of electrical power, which might be furnished for about $50 per horsepower per year. At this rate the best pumping plants of Salt River Valley can raise water at a cost of 1.2 cents per acre-foot per foot of lift, or at an average cost per acre-foot of pumped water of something like 75 cents for the present lift.

22. The value of an acre-foot of water applied to irrigation in Salt River Valley varies from $3.65 to $56.45.

23. The volume of underflow is large, but not inexhaustible by the operation of pumps. It is capable of extended development, but there is danger that a greater draft will be made upon it than is consistent with the maintenance of the water level within practicable pumping distance.

INDEX.

A. Page.

Agua Fria, location of 131
profile through Tonto basin and 117
underflow of, analysis of 141
Algeria, eastern, analyses of water in 150
irrigation methods in 149–150
Alhambra Hotel, Mesa, well at, description and statistics of 46, 138
Alkali, black, absence of, from area of profitable pumping 148
Alkaline waters, use of, in irrigation 149–150
Alkire, Frank, wells of, description and statistics of 86–87, 93, 137, 143
Analyses, mechanical, of water-bearing material 163–166
mechanical, results of, table showing 166
of caliche 108
of water from Alhambra Hotel well, Mesa 46, 138
from Frank Alkire's well 87, 137, 143
from Bartlett-Heard Land and Cattle Company's well 68, 142
from Robert Bowen's well 42, 142
from H. L. Chandler's wells 37, 126–127, 137
from George U. Collins's well 76, 139
from Consolidated Canal Company's wells 21, 26, 28
from Cooperative Company's ditch 127
from Desert well 41, 138
from Bristol Flummerfelt's well 38, 142
from B. A. Fowler's well 90, 137
from Gila River 140
from Gila Valley lake 127
from Glendale beet-sugar factory well 85–86
from Glendale town well 88, 137, 144
from H. W. Hamilton's well 89

Page.

Analyses of water from A. J. Hansen's wells 32, 126, 127
of water from J. J. Harris's well 79
from John Heaton's well 81
from A. R. Jenkins's seepage ditch 45
from Kunz & Sons' well 73, 139
from P. Mets's well 46, 138
from Thomas Murphy's well No. 1 83
from W. J. Murphy's well 85, 137
from Murphy-McQueen wells 15, 138
from E. Olsen's well 31, 126–127, 138
from Ostrich ranch well 80, 142
from C. W. Perkins's well 67
from Phoenix Indian School wells 72, 138–139, 142
from Phoenix Water Company's wells 65, 143
from Richardson ditch 82, 141
from Sahara oases, Algeria 150
from A. H. Smith's well 88, 137
from Tempe waterworks wells 35
from Territorial Asylum well 70
from underflow of Salt and Gila rivers 127
from Valley Seedless Grape Company's wells 34, 141
from Lewis Wetzler's well 74, 141
from J. A. Wieder's well 90, 139, 143
tables giving 137–145, 146
Ancient river channels, location of 125–127
Andrada, Sylvester, well of, description of 43
Apache group, correlation of 96
Apgar, W. A., reference to 152
Archean rocks, occurrence of 95
Argillites, plate showing 96
Arizona, central, map of 11
vegetation in, effect of salts on 148–149
Arizona Agricultural Experiment Station, crops at 183–184

Page.
"Arizona inches," equivalent of 19
Asylum for the Insane, Territorial, well at, description and statistics of 69–70

B.

Babb, Cyrus C., reference to 152
Baker, Sheldon, reference to 147
Bartlett, S. C., well of, description of 86, 93, 132
Bartlett-Heard Land and Cattle Company, well No. 3 of, pumping test at, depression of water table during, figure showing 68
wells of, description and statistics of 38–39, 67–69, 142
Beet-sugar factory. *See* Glendale.
Beldon, D. W., reference to 66
Bell Butte, view of 100
water table at 123
Bellerophon sp., occurrence of 97
Benson, bed rock at, depth to 112
Ben Hadrian, garden of, Algeria, analysis of water in well at 150
Blake, William P., cited 99, 107–108
reference to 110, 111
Bowen, Robert, reference to 106, 107
well of, description and statistics of 42, 142
Bowlder beds, extent of 134
See also Valley fill.
Bradshaw, J. R. and W. W., well of, description and statistics of 78, 91
Brown, J. L., well of, description of 78
Buchanan, Thomas, reference to 40, 41
Buckeye canal, flow of water in 152
Bureau of Soils, information obtained by, in eastern Algeria 149–150
tract leased by, for demonstration of reclamation methods 149
Burrows, C., well of, description of 89

C.

Caliche, occurrence and character of 107–111, 186
California, pumping in, cost of 179, 181–182
underflow in, velocity of 169
Camarotœchia metallica, occurrence of 97
Camelback Mountain, rocks of 95, 98
view of 98, 118
Canal water, cost of 179
Carboniferous rocks, occurrence and character of 97–98

Page.
Carpenter, L. C., cited on velocity of underflow 169
Cave Creek, data concerning 105, 130–131
Chandler, Professor, reference to 179
Chandler, A. J., reference to 23, 24
Chandler, H. L., wells of, conditions at 16–17, 35
wells of, description and statistics of 37–38, 114, 122, 126–127, 137
Chemical precipitates, occurrence and character of 107–111
Code, W. H., cited 12, 29, 64, 152
reference to 179
Cole, N. O., well of, description and statistics of 90, 94
Collins, George U., information from 75
plant of, data concerning 178
well of, description and statistics of 75–76, 91, 139, 148
gravel at and one-half mile north of, mechanical analyses of 164
plate showing 34
Colorado, underflow in, velocity of 169
Colorado River, rocks and deposits on 112
Consolidated Canal Company, plant No. 1, description and statistics of 18–22
plant No. 1, plate showing 18
pumping tests at, depression of water table during, figures showing 19, 20
plant No. 2, description and statistics of 22–24, 177, 178
plant No. 3, description and statistics of 24–26, 177, 178
plant No. 4, description and statistics of 26
plant No. 5, description and statistics of 27
plant No. 6, description and statistics of 28
plant No. 7, description and statistics of 28
power plant of, edge of mesa near, view of 28
seepage well of, description of 29
pumping from, water levels before and after, figure showing 29
wells of, description and statistics of 17–30
Cooper, J. D., pumping plant of, irrigation at, plate showing 82
well of, description of 82
Cooperative Ditch Company, water of, analysis of 127
Crinoids, fossil fragments of, occurrence of 97
Cyathophyllum sp., occurrence of 97

D. Page.

Darton, N. H., cited on underground flow 156
Davis, A. P., cited 105–106, 152
Débris, accumulations of 115
See also River débris.
Deep wells, variations of water level in 121–122
Desert vegetation, typical, near Tempe, view of 148
Desert well, caliche at 110
description and statistics of 40–41, 138
surface deposits at 104
water level in, variation in 121

E.

East Lake Park well, description of 73
Economics of the district 135–185
Egypt, pumping in, cost of 182
vegetation in, effect of salts on 149–150
Electricity, pumping water by, cost of 178, 188

F.

Faulting, occurrence of 115–116, 186–187
Fish, fossil teeth of, occurrence of 97
Flow, rates of 156–160
velocity of, in various kinds of soil, tables showing 157, 159, 160
Flow, maximum, in various kinds of soil, table showing 157
variations in, due to pressure, figure showing 158
Flow, relative, variations in, due to porosity 158
variations in, due to temperature 154
Flummerfelt, Bristol, well of, description and statistics of 38, 142
Forbes, R. H., cited 145, 146, 147, 148
note by, on caliche 110–111
reference to 15, 21, 110, 111, 136
Fossils, occurrence of, in limestones of Tonto basin 97–98
Fowler, B. A., well of, description and statistics of 90, 137
Fuller, P. E., cited on cost of pumping water 18
reference to 17, 23, 24, 36, 68, 178, 179

G.

Geology of the district 95–116, 186
Gila River, character of 117
gravel of, porosity of 174
underflow of 151
analysis of 126–127

Page.

Gila River, underflow of, volume of 170
water of, analysis of 140
Gila Valley lake, novel formation of 126
water of, analysis of 127
Gilbert, G. K., cited 112
reference to 99, 100
Girty, George H., note on fossils by 98
Glendale, beet-sugar factory at, well at, description and statistics of 85–86, 93
Glendale town well, description and statistics of 88, 137, 144
Granillo, José, reference to 43
Granite, occurrence of 95–96, 99
Gravels, water-bearing, depth to 15, 119–122
deposition of 16, 118
extent of, figure showing 118
mechanical analyses of 163–166
occurrence of 101–102, 125
porosity of. *See* Porosity.
relations of structure and, figure showing 118
samples of 162–166
water in, quantity of 171–173, 188
wells in 118–119
See also Sheet wash.
Ground water, chemical character of 136–150

H.

Hamilton, H. W., well of, description and statistics of 88–89
Hansen, A. J., pumping plant of, plate showing 28
wells of, description and statistics of 31–32, 126, 127
Harrington well, description of 43
Harris, J. J., well of, description and statistics of 78–79, 134
Hawley, R. W., reference to 63, 91
Hayne, L. C., well of, description of 81
Hazen, Allen, reference to 162, 166, 167
Heard, D. B., reference to 38, 123
well of, gravel at, mechanical analyses of 165
Heaton, John, well of, description and statistics of 80–81
Hough, Samuel, well of, description of 88

I.

Igneous rocks, occurrence of 100, 186
Indian canal, amount of water received by 152
Indian School. *See* Phoenix Indian School.
Insane Asylum. *See* Asylum for the Insane.
Irrigation, by bucket method, plate showing 82

Page.

Irrigation, methods of, in Sahara oases ---------- 149–150
use of alkaline and saline waters in ---------- 149–150
value of ---------- 183–184

J.

Jenkins, A. R., seepage ditch of, description and statistics of ---------- 44–45
Johnson, B. F., well of, description and statistics of --- 39–40

K.

Kansas, underflow in, velocity of- 156, 169
Kassasin, Egypt, cost of pumping at ---------- 182
Kellner, E. F., well of, description and statistics of --- 79, 132, 134, 161
King, J. Q. A., reference to ------ 163
King, Professor, reference to ---- 179
Kleinman, Daniel, well of, caliche at ---------- 110
well of, description and statistics of -------- 41–42, 110
Knox, W. H., reference to ------- 181
Kudi Asli, oasis, Algeria, analysis of water in well at- 150
Kunz, L., & Sons, well of, description and statistics of 72–73, 91, 139, 148, 177–178
Kuntze, R. E., reference to ------- 72

L.

Lambeye canal, amount of water received by ------- 152
Lava, occurrence of ---------- 100
Lee, W. T., cited ---------- 125, 136, 170
Leighton, M. O., reference to ----- 147
Leon canal, amount of water received by --------- 152
Leptopora typa, occurrence of ---- 97
Lift, profitable, height of -------- 135–136
Lester, Francis E., cited on pumping in New Mexico- 180

M.

McCallum, N. P., well of, description and statistics of 74–75, 91, 131
well of, gravel at, mechanical analyses of ------- 165
McClatchie, Alfred J., cited on value of water ----- 183–184
McDowell, Mount, cross section of Verde Valley near-- 101
location of ---------- 101
rocks near ---------- 115
Mann, J. S., reference to -------- 107
Maricopa and Salt River canals, amount of water taken by --------- 152

Page.

Means, Thos. H., cited on alkaline and saline waters in irrigation --------- 149–150
reference to ------- 136, 145, 181, 182
Menophyllum excavatum, occurrence of ---------- 97
Meridian canal, amount of water received by -------- 152
Mesa, deep well at, data concerning ---------- 115
elevation of ---------- 115
water table at, decline of ---- 121
Mesa region, gravels of -------- 118–119, 125, 128–129, 187
ground water in, level of, variations in --------- 64
location of ---------- 11
map and sections of --------- 120
physiography of ---------- 118–131
structure of ---------- 101–102
water of, quality of -------- 46–47
water table in, position of- 119–122, 187
well records in ---------- 12–64
Mesa Township, shallow wells in, table giving records of ---------- 48–59
water table in ---------- 119–122
Messinger, M. W., well of, description and statistics of 85, 91
Mets, Phil, well of, description and statistics of-- 45–46, 138
Mex, Egypt, cost of pumping at-- 182
Miller, Edward, well of, description and statistics of 87
Moore, W. G., well of, description of ---------- 80
Mountains, relations of plains and ---------- 117–118, 131
Muldrow, Robert, reference to--- 48, 60
Murphy, M. M., reference to ----- 151, 152
Murphy, S. J., well of, log of---- 16
well of, section of ---------- 12
Murphy, Thomas, wells of, description and statistics of ---------- 82–84, 114
Murphy, W. J., well of, description and statistics of ---------- 84–85, 91, 137
Murphy-McQueen pumping plant, caliche at --------- 109–110
plate showing ---------- 12
Murphy-McQueen wells, description and statistics of -- 12–17, 114, 125, 138, 161
gravel at, mechanical analyses of ---------- 166
water level in, after pumping, figure showing- 14

N.

Nelson & McIlwaine wells, description and statistics of--- 76–78, 91, 177–178
New Mexico, pumping in, cost of- 180–181

O. Page.

Olsen, E., wells of, description and statistics of 30-31, 126-127, 138
wells of, water level in, variation of 121
Orme, J. P., well of, description and statistics of 89, 93, 94
Orme, L. B., well of, description and statistics of 89, 94
Ostrich ranch well, description and statistics of 79-80, 142

P.

Parry, T. J., well of, description and statistics of 43-44, 177-178
Peninsula canal, amount of water received by 152
Perkins, C. W., well of, description and statistics of 66-67
Perry, Wm. H., well of, description and statistics of 78, 91
Phoenix, canals west of, amount of water received by 152
Phoenix Indian School, water table at, decline of 121
wells at, description and statistics of 70-72, 132-133, 138-139, 142
Phoenix Light and Fuel Company, well of, description and statistics of 66
Phoenix Machine and Cold Storage Company, well of, description and statistics of 67
Phoenix Mountains, base of, map of 117
rocks of 96
tilted pre-Cambrian quartzites and argillites in, plate showing 96
Phoenix Peak, view of 96
Phoenix region, distribution of material in 131-132
extent of bowlder beds in 134
geographic changes in 133
gravel of 102, 187
limits of 11
physiography of 131-134
structure of 102
water table of 133
well records in 64-94
Phoenix Water Company, wells of, description and statistics of 64-65, 91, 143
Physiography of the district 117-134
Plains, relations of mountains and 117-118, 131
Platyceras sp., occurrence of 97

Page.

Porosities of soil, constants for 155
Porosity, determination of 162-168, 173-174
of Salt River Valley 171
practical, discussion of 173-176
See also Flow.
Pre-Cambrian rocks, occurrence and character of 95-97, 186
plate showing 96
Pressure. *See* Flow.
Price, J. A., well of, description of 43
Productus lævicosta, occurrence of 97
Pumping, amount of, possible under existing conditions 175-176, 187-188
cost of, at Collins plant 76, 177-178
at John Heaton's well 81, 177-178
at Kunz garden 73, 177-178
at Murphy-McQueen ranch 13-14, 177-178
at Nelson & McIlwaine plant 77-78, 177-178
at T. J. Parry's plant 44, 177-178
by Consolidated Canal Company 23-24, 25, 177-178
by Phoenix Light and Fuel Company 66
by Valley Seedless Grape Company 34, 177-178
discussion of 177-182, 188
from Tempe waterworks wells 36, 177-178
in Arizona, Wisconsin, and California 179-180
in California 181-182
in Egypt 182
in New Mexico 180-181
in Salt River Valley 177-179
with electric power 178, 188
profitable, area of 135-136, 187
See also Alkali.
Pumping plants, location of 176, 184-185
views of 12, 18, 28, 82
Pumps, capacity of, table showing 180
number of, required to raise water of underflow 175

Q.

Quartzites, plate showing 96
Quaternary formations, occurrence and character of 100-116
Queen Creek, description of 104-107
discharge of 105-106

R.

Rainfall, average annual 129
Ransome, F. L., cited 96, 112, 115
Reserve. *See* Underground water.
Return water, estimated amount of 151-153
Rhipidomella sp., occurrence of 97

Page.

Richardson ditch, description and statistics of 81–82
River débris, in valley fill, occurrence of ... 102, 129–130, 186
River gravels, mechanical analyses of 163
Rogers, E. L., reference to 156

S.

Sacaton Mountains, location of .. 117
rocks of 95
section through Salt River Mountains and 126
Sahara oases, analyses of water in 150
irrigation methods in 149–150
St. Johns canal, flow of water in .. 152
Saline waters, use of, in irrigation 149–150
"Salt Banks," upper Salt River, plate showing 146
Salt River, ancient channels of .. 125–128, 133, 187
canals from 151–152
character of 117, 122
gravel from 162–163
rocks on 97
salt banks on, plate showing .. 146
underflow and, relations of .. 122, 129
underflow of, analyses of 126–127
measurement of .. 151–153, 160–161
volume of 151–152, 170
See also Underflow; Gravels, water-bearing.
waters of, analyses of .. 141, 145–146
irrigation by 148
Salt River and Maricopa canals, amount of water taken by 152
Salt River dam site, view of 96
Salt River gorge, section through, at Tonto dam site .. 97
Salt River Mountains, location of .. 117
rocks of 95
section from, to Sacaton Mountains 126
section through Tempe Butte to 126
Salt River Valley, cost of pumping in 177–179
economics of 135–185
geology of 95–116
gravels of 162–167
history of 112–114, 129–131
ideal cross section in 16
index map of 120, 124
map of, showing area of profitable pumping .. 135
showing location of pumping plants 176
part of, geologic map of 95
map of 122
physiography of 117–134

Page.

Salt River Valley, pumping in, cost of 177–179
section across 126
surface movements in 115–116, 186–187
water entering, amount of, impossibility of measuring 151
well records in 12–94
Salts, effect of, on vegetation .. 148–150, 187
occurrence and character of .. 111, 147–148, 187
origin of, in river water 147–148
in well water 145–147
See also Alkali.
San Pedro River, valley of, deposits in 115
Schuchertella inæqualis, occurrence of 97
Section, cross, of Salt River Valley, ideal 16
Sedimentary rocks, occurrence of .. 97–100
Seepage land near Tempe, plate showing 118, 150
Seepage water, amount of 151–152, 170–171, 187
Seepage well near power house of Consolidated Canal Company, description of 29
Seminula humilis, occurrence of .. 97
Shallow wells, Mesa and adjoining townships, table giving records of 48–63
Mesa region, variation in quality of water 46–47
Phoenix region, table giving records of 91–94
variations of water level in .. 120–121
Sheet wash, occurrence and character of ... 102–107, 130, 186
water of 129
Sierra Ancha Mountains, sketch profile through 117
Silva, Alexander, well of, description and statistics of 87, 93
Skinner, W. W., reference to .. 21, 136, 137
Slichter, Charles S., analyses by, of gravel from Collins well 167–168
cited on measurement of underflow 153–160, 162, 169
reference to 153, 162, 166, 167, 170
Slichter method, application of ... 168
necessary factors in 160–168
Smith, A. H., well of, description and statistics of 88, 93, 137
Smith, G. W., well of, description of 72
well of, gravel from 173
Spirifer centronatus, occurrence of 97
sp., occurrence of 97
Spurr, J. E., descriptions of rock by 95–96, 100

Page.
Straw, A. J., reference to 86
Superstition Mountains, north end of, view of 100
rocks near 104
Surface movements, description of 115–116, 133, 186–187
diagrams illustrating 113
Syringopora aculeata, occurrence of 97
surcularia, occurrence of 97

T.

Tabesbest, oasis, Algeria, analysis of water in well at 150
Tempe, buttes north of, view of 98
rocks near 98, 113, 123
seepage land near 118, 148–149, 150
water level at, variation in 64, 121, 128
waterworks wells at, description and statistics of 34–37, 177–178
Tempe Butte, description of 115–116, 124
geologic map of 116
rocks of 98, 100
section through 116
to Salt River Mountains 126
view of 34, 100
Tempe Canal Company, wells of, description and statistics of 33
Tempe-Mesa Produce Company, well of, description and statistics of 40
Tempe Township, shallow wells in, table giving records of 61–63
Temperature, flow of ground water and, relations of 154
of wells, table showing 161
variations of, with depth 17, 22, 161
Tertiary (?) deposits, occurrence and character of 98–100, 114
Tertiary lavas, occurrence and character of 100
Tonto basin, clay bank in, plate showing 112
fossils from 97
history of 112–114
rocks of 96
side canyon in, view of 96
sketch profile through 117
tilted breccia in, plate showing 112
tilted formations at upper end of, plate showing 98
Tonto dam site, section through Salt River gorge at 97
Topography, changes in 115–116, 133, 186–187
Township 1 south, range 5 east, shallow wells in, table giving records of 61
Township 1 north, range 6 east, shallow wells in, table giving records of 60
Township 2 north, range 4 east, shallow wells in, table giving records of 63
range 5 east, shallow wells in, table giving records of 60–61

U.

Underflow, accessions to 151–153
area of cross section of 160–161
character of 124, 128
courses of 123–128
exhaustion of 175–176, 188
lake due to 126
method of measuring 153–171
quantity of, in various other regions 160
rates of 156–160
relations of river and 122, 129
return of 151–152, 170–171, 187
sources of 122, 128–131
temperature of 161–162
velocity of 156–158, 169
volume of 134, 151–171, 187–188
water from, analyses of 127
See also Flow; Underground water; Water.
"Underground lake," use of expression 124
"Underground river," use of expression 124
Underground water, areas of, map showing 176
depth to 171
flow of, into drainage ditch 159
See also Flow.
irrigation from, possibilities of 172
plane of, depression of 171–173
level of, relations of surface and 119–122, 133
sections showing position of 102, 120, 122
quantity of 151–176, 187
reserve, amount of 171–173, 188
source of 120–122, 187
See also Gravels, water-bearing; Underflow; Water.

V.

Valley fill, age of 111–114
description of 101–114
manner of deposition 16, 129–131, 186
material of 102–111, 131–132
structure of 101–102, 123–125
See also Gravels, water-bearing.

Page.

Valley Seedless Grape Company, wells of, description and statistics of 33–34, 104, 123, 141, 161, 177–178
Value of water. *See* Water.
Vegetation, effects of salts on 148–150
Velocity of flow. *See* Flow.
Verde Valley, cross section of, near Mount McDowell 101
Vernon, John J., cited on pumping in New Mexico 180
Viscosity of water, variations of, with temperature 154

W.

Wagner, Frank, well of, description and statistics of 74, 91
Walcott, Charles D., reference to 96
Wash, definitions of term 102–103
See also Sheet wash.
Water, amount of, available for pumping 173–176
amount of, in soils of different porosity 174
now being withdrawn from underflow 175
analyses of. *See* Analyses.
value of 135–136, 183–184, 188
See also Flow; Return water; Underflow; Underground water.
Water level, variations of, in deep wells 121–122
in shallow wells 120–121
Water table, depression of, due to construction of drainage ditch, figure showing 159

Page.

Water table, depression of, during pumping tests 19, 20
position of, in Mesa Township, map and sections showing 120
relation of, to river and land surfaces, sections indicating 102
Water-bearing gravels. *See* Gravels, water-bearing.
Well records. *See* Salt River Valley.
Wells. *See* Deep wells; Shallow wells.
Wetzler, Lewis, well of, description and statistics of 74, 91, 141
Whitlow ranch, Queen Creek at, flow of 106
Wieder, J. A., well of, description and statistics of 90–94, 139, 143
Windy Hill, fossils from 97
Wisconsin, pumping in, cost of 179
Wood, cost of, note on 76
Woodward, S. M., reference to 34

Y.

Yield of wells, underground conditions affecting, diagrams illustrating 185
Yucca, deposits at 115

Z.

Zaphrentis sp., occurrence of 97

O

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IN THE

EASTERN COASTAL PLAIN REGION OF SOUTHERN CALIFORNIA

BY

WALTER C. MENDENHALL

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CONTENTS.

	Page.
Letter of transmittal	7
Introduction	9
Coastal plain	11
Crops	11
Irrigation systems	13
San Gabriel system	13
La Habra and East Whittier Water Company	13
Santa Ana systems	14
Anaheim Union Water Company	14
Santa Ana Valley Irrigation Company	16
Santiago Canyon systems	17
Serrano Water Company	18
Carpenter Water Company	18
Drainage districts	19
Bolsa drainage district	20
Willows drainage district	20
Underground water	21
Source	21
Permanence of the supply	21
Interdependence of wells	30
Cost of wells	31
Description of maps and tables	33
Acknowledgments	35
Well data	36
Index	139

ILLUSTRATIONS.

Page.

PLATE I. Artesian areas and hydrographic contours in the valley of southern California ..... Pocket.

II. Map showing irrigated lands, canals, and pumping plants in the Anaheim quadrangle ..... Pocket.

III. Map showing irrigated lands, canals, drainage districts, and pumping plants in the Santa Ana quadrangle ..... Pocket.

IV. *A*, An uncemented portion of the upper Anaheim canal; *B*, A cemented portion of the upper Anaheim canal 14

V. *A*, Main Santa Ana canal above Burruel Point; *B*, Crest of submerged dam at Point of Rocks, Santiago Canyon 16

VI. Map showing wells, artesian areas, and water levels in the Anaheim quadrangle ..... Pocket.

VII. Map showing wells, artesian areas, and water levels in the Santa Ana quadrangle ..... Pocket.

FIG. 1. Cross section of East Whittier ditch 13

2. Diagram showing variation in water level near Anaheim, Cal 24

3. Chart showing departures from average rainfall at San Bernardino, Cal. 27

4. Chart showing departures from average rainfall at Anaheim, Cal 28

5. Diagrammatic cross section of southern California coastal plain 31

6. Map showing approximate amounts of dissolved solids in the underground waters of the eastern part of the coastal plain of southern California 34

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
HYDROGRAPHIC BRANCH,
Washington, D. C., September 23, 1904.

SIR: I transmit herewith a paper entitled "Development of Underground Waters in the Eastern Coastal Plain Region of Southern California," by Mr. W. C. Mendenhall, and recommend that it be published in the series of Water-Supply and Irrigation Papers.

This report is the first of three papers on the underground waters of the coastal plain of southern California, which are being prepared by the division of hydrology under the general direction of Mr. N. H. Darton. When the series is complete it will contain a list of nearly all the wells in this section of the State, with such data as to water levels, irrigation systems, and irrigated lands as could be collected by a careful canvass.

The studies, a part of whose results are being made available in this way, are planned to cover all the important water-bearing lands of the valley of southern California. In most instances the facts gathered concerning the wells and the distributing systems will be supplemented by a study of the local geology in so far as it controls the amount, distribution, and circulation of the ground waters. The hydrographic data and the geologic data will then be discussed and issued together in one report. In the coastal plain area, however, the geologic conditions being relatively simple, and the hydrographic data being large in volume and of paramount importance, it is deemed best to issue the latter at once, rather than to delay it pending the working out more fully of the comparatively unimportant geologic problems. Therefore the tables and maps are presented here for the consideration of water users, with a comparatively brief text, which is chiefly descriptive, but includes a discussion of the effects of development and drought in bringing about those changes in water levels and in the outlines of artesian areas which have been most marked within the last five or six years.

Very respectfully,

F. H. NEWELL,
Chief Engineer.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

DEVELOPMENT OF UNDERGROUND WATERS IN THE EASTERN COASTAL PLAIN REGION OF SOUTHERN CALIFORNIA.

By W. C. Mendenhall.

INTRODUCTION.

In California generally, irrigation engineering and water development are further advanced than in any other part of the Union, and in no other part of the State has the scientific study of water conservation, distribution, and application been carried out so fully as in the valley region near Los Angeles. The lands are highly productive when water can be applied to them. The climate is semiarid, with a rainfall of from 10 to 20 inches in the tillable areas, practically all of which is confined to the winter months. This is not sufficient to mature the more valuable crops, hence irrigation must be resorted to, and the extension of the areas of cultivation is dependent upon an increase in the water supply. The flowing waters from the mountain canyons were long ago appropriated, and the attention of irrigators and engineers during the last decade has been turned largely toward the development of the subterranean sources.

As a preliminary step in the study of the amount, availability, distribution and proper use of underground waters, the majority of the wells within the region have been visited. Data have been collected concerning the size, depth, yield, and cost of the wells, and the temperature, purity, and use of the waters. The present and past artesian areas, the irrigated lands, and the main canal systems have been mapped. Outside the artesian belts the ground-water level—the position of the surface of the plane of saturation—has also been determined as closely as possible. In short, the object of the work has been to collect all information which will be of value in the further development of the water resources or which throws light on past development and its effects. It is planned, as the work continues, to examine carefully the general geologic conditions in the water-bearing areas, as the depth, form, storage capacity, and origin of the subterranean reservoirs and the circulation of the waters within them are questions of geology. The extent to which these stored waters may safely be

drawn upon depends upon their amount and the rate at which they are replenished. Some observations on the latter question have been made, and others more extended and systematic have been begun by the Survey.

By the valley of southern California, within which this work is undertaken, is meant that region extending 30 or 40 miles south of the San Gabriel and San Bernardino mountains, and lying between the Pacific Ocean and Cajon and San Gorgonio passes. It includes the greater part of the productive lands of the southern section of the State, and within it lie most of the prosperous settlements which have become famous for their beauty, fertility, and healthfulness.

In the preliminary work on the underground waters within this region the Survey representatives have examined about 11,000 wells of all kinds, from those but a few feet in depth and used only for domestic supply or for stock, to bored wells 1,200 feet deep and yielding in many cases copious flows of irrigation water. The amount of statistical data which has been thus assembled is large, and through the courtesy and interest of water users and irrigation companies is constantly increasing.

The Anaheim and Santa Ana quadrangles,[a] which, together comprise what is called in this paper the eastern coastal plain region, include an area 35 miles long and 15 miles wide, extending from longitude 117° 45′ to 118°, and from latitude 34° to the Pacific Ocean. This area includes the lower portion of Santa Ana River below its lower canyon through the Santa Ana Mountains. The greater part of the San Joaquin Hills are within the Santa Ana quadrangle, and the central part of the Puente Hills are in the Anaheim quadrangle. Between these groups of hills lies the eastern end of the southern California coastal plain, including a part of the famous peat lands of Orange County, and the perhaps equally well-known agricultural lands about Santa Ana, Orange, and Anaheim. Under these lower, comparatively level lands the important underground waters are found. The artesian basin of the coastal plain, the largest artesian basin in southern California, with an area of about 190 square miles, occupies the northwestern portion of the Santa Ana quadrangle, and extends along the western edge of the southern half of the Anaheim quadrangle. A broad zone, originally artesian, but not now yielding flowing water, stretches across the southwestern corner of the Anaheim quadrangle. Within this zone water lies within easy pumping distance.

[a] A quadrangle is the unit of survey adopted by the United States Geological Survey for the topographic and geologic atlas of the United States. It is a rectangular area 15 minutes, 30 minutes, or 1 degree in extent each way, bounded by parallels and meridians, and having an area of one-sixteenth, one-quarter, or one square degree. The quadrangles disregard political boundaries, such as those of States, counties, and townships. To each is given the name of some well-known place or feature within its limits. A sheet is the topographic map of one of the above areas.

COASTAL PLAIN.

The coastal plain, of which the lowlands in these two quadrangles form a part, extends from the Pacific to the base of the Puente Hills and the Santa Ana Mountains, and from the Santa Monica Mountains to the San Joaquin Hills. It is about 50 miles long and from 15 to 20 miles wide, and has an area of approximately 775 square miles. It is generally a smooth plain with an elevation along its inland edge of from 200 to 300 feet, from which it slopes gently to sea level at the coast. San Pedro Hill rises well above it, and its general regularity is interrupted by a long low ridge which extends from the vicinity of Palms to Huntington Beach. This ridge is not continuous, as a wide valley has been cut through it by each of the larger streams which flow across the coastal plain to the sea, thus breaking it into a series of detached but aligned hills of different heights. This broken ridge forms the seaward boundary of the coastal plain artesian basin. Within the area treated in this paper it is a rather inconspicuous physical feature, existing as the low, broad mesa about Huntington Beach, and perhaps as the similar feature north of Newport and enveloping the base of the San Joaquin Hills.

The coastal plain is underlain by a succession of sand, gravel, and clay beds whose constituent materials were transported to their present position by Santa Ana, San Gabriel, and Los Angeles rivers, and perhaps in small part by the waves and currents of the Pacific. This plain represents a former wide bay which was gradually filled by alluvial débris that has been redistributed, in part at least, by oceanic waters as beach sands and gravel. Convincing evidence of this factor in distribution is furnished by the recent marine shells which are so often found in deep and shallow wells and on the present surface some miles from the shore line.

CROPS.

Within the area under consideration crops and soils are varied, as is generally true throughout the coastal plain, and irrigation practice is not at all uniform. In the Anaheim quadrangle about Orange, Fullerton, and Anaheim are many citrus groves, and deciduous fruits and walnuts are extensively cultivated. Farther south, in the peat lands, celery is becoming a more and more important crop, and sugar beets, corn, and alfalfa are extensively grown.

The citrus groves require the regular application of water throughout the year, irrigation being constant, except when winter rains are sufficiently heavy to serve as a substitute. Practice is not uniform in the walnut groves, some growers maintaining that irrigation is not necessary. This may be true in moist lands, where the roots can reach the ground waters, but generally ranchers find it profitable to apply

water during the summer season. Deciduous orchards, generally in the lower lands, are under irrigation, but in the vicinity of La Habra are a number of flourishing groves which receive only the rainfall.

In preparing the peat lands for celery the soil is thoroughly flooded, and often water is turned on again once or twice before the crop is mature, but in the moister lands one or both of these later applications may be omitted. With sugar beets, also, practice varies. Water is almost invariably used in preparing the land, and is often, but not always, applied during the growth of the crop. Corn, alfalfa, potatoes, and peanuts are usually irrigated, while grapes and barley are sometimes watered during dry years, but these, with beans, are regarded as the principal dry crops.

On many of the lands which lie under the Santa Ana Valley or Anaheim canal systems, as well as on those watered from pumping plants, a certain amount of rotation is practiced, and lands which are irrigated one year may stand dry during another or may be planted to a crop requiring much more or much less water than the one grown during the preceding season. This is possible only with the annuals, of course. Groves or other crops requiring more than one year to mature can not be rotated in this way. These variations in crops and in irrigation practice make it difficult to estimate the duty of water per acre of irrigated land. Citrus lands are regarded as requiring an equivalent of approximately one miner's inch[a] continuous flow for each 5 acres. Other crops require less, some of them very much less.

The total area irrigated during the season of 1904 in the Anaheim quadrangle is estimated at 28,800 acres and in the Santa Ana quadrangle at 6,600 acres, a total of 35,400 acres.

In this estimate of the total acreage irrigated, and on the maps showing irrigated lands (Pls. II and III), those areas upon which water is applied in the manner known as "subirrigation" are not included. Subirrigation consists essentially in releasing the water on the surface or in ditches which are widely separated, whence it seeps laterally for long distances through the fine sandy subsoil which is under much of the peat lands. The method is applicable only where the water table lies near the surface. It amounts in effect to raising this water table locally, so that it may be reached by the roots of grasses, corn, beets, and other plants with short root systems. It is not possible to map the areas irrigated in this way or to estimate their amount, because the boundaries are wholly indefinite and the lands thus watered are often inseparable from those which are naturally moist enough to mature crops. This method is applied more generally to pasture lands than to cultivated areas.

[a] Wherever the term "miner's inch" is used in this report the old California miner's inch is meant. This unit is the amount of water that flows through a 1-inch orifice under 4 inches pressure. It is equal to 9 gallons a minute, one-fiftieth of a second-foot, or 14.478 acre-feet a year.

IRRIGATION SYSTEMS.

Three streams supply surface irrigating waters for the Santa Ana and Anaheim quadrangles. These are San Gabriel River, from which water is brought to a territory east of Whittier, in the La Habra district; Santa Ana River, in which the important Anaheim Union and Santa Ana Valley systems originate; and Santiago Creek, which supplies the Serrano and Carpenter ditches, in the vicinity of Villa Park and El Modena.

SAN GABRIEL SYSTEM.

LA HABRA AND EAST WHITTIER WATER COMPANY.

The La Habra and East Whittier Water Company procures water from the San Gabriel Valley, above the Paso de Bartolo, by means of a battery of wells and pumps. The water is discharged into an old

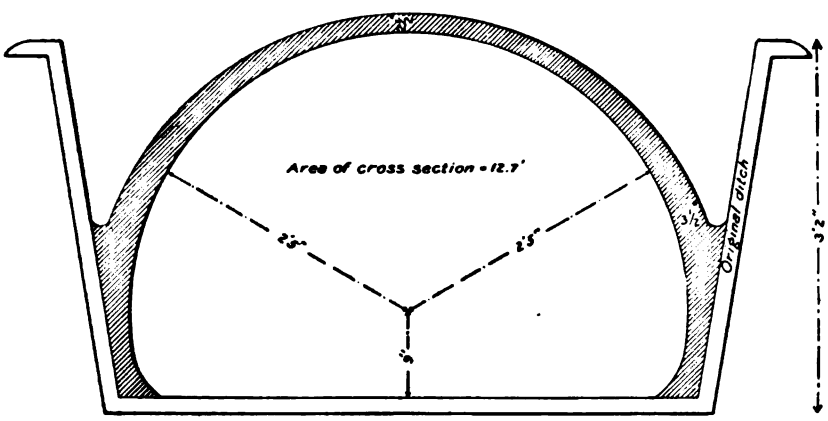

FIG. 1.—Cross section of East Whittier ditch.

ditch which has been covered with concrete and so converted practically into a pipe line (fig. 1). This line extends to Pickering avenue, Whittier. From Pickering avenue to the La Habra pumping station the water flows through a 36-inch wooden pipe line. From the pumping station about 3,300 feet of 26-inch steel pipe is used for the lift of 110 feet to the reservoir above. A 120-horsepower steam pump has been installed for this lift.

From this reservoir about 6,000 feet of cement pipe extends to an arroyo southeast of the pumping station, and a 24-inch concrete pipe runs from this point to the center of sec. 5, T. 3 S., R. 10 W. A 22-inch pipe extends thence to the reservoir and pumping station on the west line of the Rancho San Juan Cajon de Santa Ana. From this station a lower 22-inch gravity line extends to the east side of Brea Canyon, and a line about 2,000 feet long, with a lift of 66

feet, extends to a distributing box above the pumping station, whence a distributing pipe, in part steel, extends eastward to beyond Brea Canyon.

From the La Habra station the California Domestic Water Company has a gravity line running southward for 2 or 3 miles toward Coyote Creek and serving the adjacent lands.

SANTA ANA SYSTEMS.

All of the water flowing in Santa Ana River at Bedrock Canyon, 4 miles west of Rincon, where its flow is supposed to be at a maximum, is taken from the river bed and divided equally between the Anaheim Union Water Company, which supplies the lands north of the river, and the Santa Ana Valley Irrigation Company, which serves the lands south of the river.

A division box of wood, supported by piling, has been built at Bedrock Canyon. One-half the water of the river is diverted here into the Anaheim Union Water Company's canal; the other half, after the division, is returned to the river bed, and is taken out again at the headworks of the Santa Ana Valley Irrigation Company's canal 3 miles below.

ANAHEIM UNION WATER COMPANY.

According to the report of William Ham. Hall, formerly State engineer of California, the Anaheim Union Water Company is the successor to the earlier rights held by the Anaheim Water Company, the Kramer ditch, and the North Anaheim Canal Company and its predecessors, the Cajon Irrigation Company and the Cañon de Santa Ana Water Company.

The Kramer ditch was the oldest of the water rights acquired. It had taken water from the river several years before the founding of Anaheim in 1857, and had used those waters to irrigate the Kramer tract. For its rights, the Anaheim Union Water Company gave 20 shares of nonassessable stock.

The Los Angeles Vineyard Society, organized in 1856, secured 1,165 acres of land from the Rancho San Juan Cajon de Santa Ana and a water right based on the riparian rights of the rancho. It built a ditch and diverted sufficient water to irrigate nearly 2,000 acres. In 1860 all the water rights, ditches, canals, and rights of way belonging to the society were conveyed to the Anaheim Water Company.

The Cajon Canal was begun in 1875, under the authority of the Bush act of 1874, which provided for the organization of irrigation districts in Los Angeles County, under the supervision of a county superintendent of irrigation.

District No. 1 was organized and built a small ditch, about 3 feet wide on the bottom, to the mouth of the canyon; District No. 2, formed

A. AN UNCEMENTED PORTION OF THE UPPER ANAHEIM CANAL.

B. A CEMENTED PORTION OF THE UPPER ANAHEIM CANAL.

later, joined the first district and the canal was enlarged to its present size. After an expenditure of $40,000 the work was abandoned.

In 1876 the Stearns Rancho Syndicate organized the Cañon de Santa Ana Water Company, with a capital stock of $200,000, and took possession of the canal. No work, however, had been done at the end of two years.

In 1877, seven landowners organized the Cajon Irrigation Company with a capital stock of $20,000. They filed on 4,320 miner's inches of water at the head of the partly completed Cajon canal, took possession adversely to the claim of the Cañon de Santa Ana Company, and brought suit to quiet title. The suit never came to trial, but possession on the part of the new company was never strongly resisted by the older, less active organization.

The stockholders of the new company, although not wealthy men and having a hard struggle to raise the necessary means, managed to continue construction upon their canal. At the time when they were most deeply involved, they sold one-half interest to the Anaheim Water Company for $20,000, and with these funds continued the work. In 1882, because of defects in their original organization, they reorganized, taking the name of the North Anaheim Canal Company, whose rights had been purchased for $500 in 1878. This last-named company was organized in 1872 to irrigate land northwest of Anaheim. Its ditch, with a capacity of 1,500 miner's inches, rarely received water except in winter.

The joint ownership of the Cajon canal by the Anaheim Water Company and the Cajon Company was never a satisfactory arrangement. Disagreements about the division of water led to lawsuits, and in 1884 a consolidation, resulting in the formation of the present Anaheim Union Water Company, was effected.

Under its present organization, which was completed in January, 1884, the $1,200,000 capital stock of the company is divided into 12,000 shares, of which 8,004 shares, representing 8,004 acres under irrigation, have been sold, the balance being held as treasury stock. The par value of the stock is $100 a share, and the present (1904) market value is about $65 a share. Stock in the water company is not appurtenant to the land, but may be bought or sold independently.

The main canal, of cement or earth construction, has a capacity of about 26 heads of 100 miner's inches each. The minimum supply is given as about 800 miner's inches. Hall gives the length of the main canals and branches as over 100 miles, and the officers of the company state that about 35 miles of laterals are cemented. (See Pl. IV.)

One share of stock entitles the owner to one head of 100 miner's inches for one-half hour during each run throughout the summer season

of minimum supply. When water is abundant there is no time limit, and all the water that the irrigator desires to purchase may be taken out. The water to which ownership of stock entitles the holder is paid for at present according to the following schedule:

Charge for water under canals of Anaheim Union Water Company per head of 100 miner's inches per hour.

November, December, January, and February	$0.30
March	.40
April and October	.50
May and September	.60
June, July, and August	.80

In addition to these payments for water, assessments are made each year to pay interest on debt and to make improvements. Of late years these assessments have averaged about $3.50 per year per share.

SANTA ANA VALLEY IRRIGATION COMPANY.[a]

The water rights of the Santa Ana Valley Irrigation Company, which serves the greater part of the irrigable lands south of Santa Ana River as far as Santa Ana and Tustin, are based on the riparian rights of the Rancho Santiago de Santa Ana to one-half of the water of Santa Ana River.

When this ranch was partitioned among its owners by decree of the court in 1868, each owner was given the right to divert from the river his share of the water for irrigation. A number of ditches were constructed from time to time on the basis of this right, the majority of them being afterwards abandoned. The rights of one of these were secured by the Chapman ditch, which was extended as far as Orange in 1871. In 1873 it was sold to the Semi-Tropic Land and Water Company and extended to Santa Ana and Tustin. This ditch and the Watson ditch, which it supplied, diverted one-half the waters of the river; the other half, which belonged to the irrigators north of the river, was in large part lost in the sandy bed of the stream before reaching the head of the Anaheim ditch. The result was a shortage of water on the lands served by the Anaheim ditch, and a suit was begun against the Semi-Tropic Water Company to establish the right of the Anaheim ditch to water amounting to its full capacity. In the lower court the decision was against the Semi-Tropic Company, but in an appeal this decision was reversed, the case remanded for trial, and a recommendation made by the court that the litigants agree upon an equal division of the water. This recommendation was accepted, litigation ceased, and the south-side irrigators have since held undisputed possession of one-half the flow of the river.

[a] The sketch of the earlier history of this organization, as of the Anaheim Union Company, is condensed from "Irrigation in California," by William Ham. Hall.

A. MAIN SANTA ANA CANAL ABOVE BURRUEL POINT.

B. CREST OF SUBMERGED DAM AT POINT OF ROCKS, SANTIAGO CANYON.

In 1877 the Santa Ana Valley Irrigation Company was incorporated with a capital stock of $100,000, divided into 20,000 shares. Its object was to extend the benefits of irrigation to the 20,000 acres of the original rancho entitled to water. Improvement of the original system was immediately begun and has been gradually extended until now the greater part of the main canal and laterals are cemented, and excellent service is rendered.

Of the 20,000 shares, 16,055 are sold, the balance remaining in the treasury. The par value is $5 per share; but as all assessments are added to the cost of shares, and as the value of the property has increased, these now (1904) have a market value of about $60.

The stock is appurtenant to the land, and may not be sold independently of it. Each share entitles the holder to 1 head of 100 miner's inches of water for a half hour each run during periods of scarcity and for an hour during ordinary periods. When water is abundant the irrigator may use all the water he wishes by paying the current rates. These rates are, during the day, 20 cents per 100 miner's inches per hour; during the night, 10 cents per 100 miner's inches per hour.

The company is well managed, has a small debt, and its system is in splendid condition. Service is rendered at a very low rate. The main canal (Pl. V, *A*) extends from the intake in the lower canyon of the Santa Ana to Burruel Point, a distance of about 9 miles. More than half of this canal is cement lined, with an average width at bottom of 12 feet, a depth of 5 feet, and a width at top of 22 feet. Its capacity is about 7,000 miner's inches. Below Burruel Point the main canal is divided into an upper and lower canal, from which a complete system of laterals forms a network through the country served. The principal laterals, as well as the main lines of the system, are shown on Pl. II.

SANTIAGO CANYON SYSTEMS.

Two small but efficient and interesting irrigation systems are served by the waters of Santiago Canyon.

At a narrow point in the canyon, known as the Point of Rocks, about 2½ miles above Villa Park, a very successful submerged dam (Pl. V, *B*) has been built across the channel of the stream. It extends from rim rock to rim rock, a distance of 110 feet, and has a maximum height, where the channel is deepest, of 19 feet. At this point its width on the bottom is 12 feet. It has a uniform width at the top of 3½ feet along its entire length. An earlier clay dam had been built at the same point, but after its partial destruction by floods the present rock and concrete structure was built in 1892 by the Serrano and Carpenter associations, jointly, at a cost of $3,700. All of the underflow of Santiago Creek at this point is forced to the surface, and as a result a continuous flow of 40 or 50 miner's inches is maintained throughout

the dry season. Some distance above the dam, in the valley of Santiago Creek, a reservoir of earth and sand is filled by the winter floods and is allowed to drain slowly away by seepage into the gravels of the creek bottom during the succeeding dry months. This helps to maintain the summer flow over the surface of the submerged dam. Without these inexpensive but most successful works all of the summer flow of Santiago Creek, during dry seasons at least, would escape by subsurface percolation.

From the submerged dam (Pl. V, *B*) the water is conducted along the south bank of Santiago Creek for 750 feet in a 28-inch cement pipe to a division gate, where it is divided equally between the Serrano and Carpenter companies, operating on the north and south banks of Santiago Creek, respectively.

SERRANO WATER COMPANY.

The Serrano Water Company's right dates back to an appropriation of one-half the waters of Santiago Creek by Bush and Watson in 1872. This right was later transferred to others, and in 1876 the Serrano Water Company was organized by J. O. and R. F. Lotspeich and five others, who held the right at that time.

Previous to 1879 the water was diverted by primitive dams into earthen ditches, but during that year a submerged dam of clay was constructed to bed rock and a cement distributing pipe laid from the dam to the lands served. In 1892, the older dam having been partly destroyed by flood, it was replaced by one of rock and cement, which is still in use. From the division gate below this dam the Serrano Company has 3,200 feet of 20-inch cement pipe to a division gate between the two tracts known as the Lotspeich and Grey tracts, served by this association. On the Lotspeich tract are about 3 miles of cement pipe from 10 to 16 inches in diameter, and on the Grey tract are about 1½ miles of similar pipe. In addition, the final distribution on a portion of each tract is made by open ditches. The association has 70 members and serves 1,303 acres. The water is apportioned to each member in proportion to his acreage, and runs through in 18½ days.

CARPENTER WATER COMPANY.

October 1, 1872, John F. and Alexander Carpenter entered upon and appropriated one half the water of Santiago Creek, the other half having been appropriated by Bush and Watson at an earlier date. J. F. Carpenter built the first ditch soon after his purchase, and conveyed his land and water rights to Oge and Bond in 1874. About 1881 the first pipe line of 10 and 12 inch cement pipe was constructed. It was extended in 1883 to the Santiago Land and Water Company's reservoir north of El Modena.

This original pipe line gave unsatisfactory service because of its small capacity, and in 1902 a new line was laid at a cost of $8,000. It consists of 2,400 feet of 20-inch cement pipe, 3,600 feet of 18-inch cement pipe, and about 9,000 feet of 16-inch pipe.

This company, unlike the Serrano Association, was incorporated in 1901, the stock being divided into 1,600 shares, at a par value of $10 per share. One thousand shares are distributed, and the remainder is held as treasury stock. The shares may not be sold except with the land.

When the water is low each irrigator uses the entire supply for 16½ minutes for each acre irrigated. At this rate it takes 18½ days to make a "run;" that is, to water once all of the lands under the pipe lines. When water is more abundant the lands served are divided into two or three sections, which are served simultaneously, and use the water for 33 or 49½ minutes per acre each, so that a run as before requires 18½ days, but each irrigator gets two or three times the amount of water that is served him when the supply is low. The light running expenses are provided for by annual assessments on the stock.

The title to the waters of Santiago Creek for irrigation purposes, as vested in the Carpenter and Serrano companies, was fully confirmed in a decision rendered June 1, 1896, in the superior court of Orange County, in which the owners of Rancho Lomas de Santiago were perpetually enjoined from using the waters, except for domestic purposes or for stock.

Both the Serrano and Carpenter companies are models of efficient and economical construction and management.

DRAINAGE DISTRICTS.

The reclamation of the peat lands in the western part of the Santa Ana quadrangle and in adjacent quadrangles to the west has been a problem of drainage rather than of irrigation. As these lands are generally nearly flat for long distances, or at best have a very gentle if uniform slope toward the coast, it has not been practicable for an individual farmer or ranch owner alone to undertake drainage. Successful ditches must be extended to the tidal sloughs to secure an outlet. This has often meant some miles of construction, and has necessitated cooperation on the part of the benefited landowners. The lands of the district are dark, especially fertile soils, enriched by vegetable mold. Without artificial drainage they are generally too damp for cultivation, since they include the lowlands along the lower course of Santa Ana River and overlying the lower edge and most effective portion of the artesian basin. Strong springs, representing leakages from the artesian waters below, are found at a number of points. The flow from these has kept the lands about them saturated

even during the dry season, and the first and most important problem has been to provide for the free escape of these spring waters.

Under a State law, passed in 1897, two drainage districts have been organized, each with its governing board of three directors, who properly apportion the expenses among the landowners benefited. The assessments for the maintenance of the systems are determined by these directors, the county collects them with the other taxes, and warrants are then drawn upon the county treasurer for expenses incurred in construction and maintenance.

BOLSA DRAINAGE DISTRICT.

Only a part of the Bolsa drainage district, the older of the two organizations, is in the Santa Ana quadrangle. It includes the region about Smeltzer and Celery and an area to the west in the Los Bolsas quadrangle.

The earliest ditch in this district is said to have been begun by the Stearns Rancho Company many years ago. Later the county extended the original Bolsa ditch, and finally, in 1899, the Bolsa drainage district in its present form was organized. It includes about 2,400 acres, and perhaps 15 miles of ditch have been dug. The network of ditches is being slowly extended, and much tile underdrain with outlets in the main ditches is being put in by ranchers. Maintenance is said to cost about $1,000 per year, and an additional sum is spent each season for new construction.

WILLOWS DRAINAGE DISTRICT.

The Willows drainage district was finally organized, after several unsuccessful attempts, during the spring of 1904. It includes an area of about 9,000 acres, centering about the village of Talbert. A number of old ditches, built by individual or community effort and varying in length and character of construction, are included in the district as now organized. One of the most important of these is the Willows ditch, dug in 1899 by Messrs. Lamb, King, Newland, and Bourchard. It is about 6 miles long, 6 or 7 feet wide, and 3 or 4 feet deep. It cost about $1,800.

The Lamb and Bourchard ditch was begun as a small ditch in 1875. In 1898 it was enlarged and extended, and is now about 3½ miles long, but of varying width and depth. The Newlands ditch is about 3½ miles long, 6 feet wide, and 3 feet deep.

The district at present includes about 20 miles of canals, but has been bonded for $20,000; $10,000 of the bonds are being sold and with the proceeds it is planned to perfect and extend the present system until about 28 miles of main canals are constructed.

The lands reclaimed by these systems are proving to be among the richest and most valuable in this part of the State.

UNDERGROUND WATER.

SOURCE.

The sands and gravels that underlie the coastal plain are saturated, from a point whose distance below the surface varies with locality, to bed rock, which lies at an unknown depth. The water has been supplied chiefly by the large streams that flow across the coastal plain and derive their supply from the higher mountains, where precipitation is greater and direct evaporation less than in the lowlands.

The amount at present stored in these gravels represents slow accumulation through long periods. Even through the summer it without doubt receives accessions from the underground flow of the larger rivers, from slow drainage of the slopes of neighboring hills, and from return waters from irrigation; but these contributions must be very small as compared with those received through the absorption of flood waters and direct rainfall during the winter. The winter accessions are received mainly along the inner edge of the coastal plain, where the rivers first discharge upon it, and where its sands and gravels are coarser; hence the saturating water must move slowly seaward at varying rates, which depend upon the coarseness of the medium through which it is percolating. Some of it passes beneath the clay beds which alternate with the sand and gravel in the flatter lower portions of the coastal plain and dip with the general surface toward the sea. The water beneath such a sloping, impervious clay bed finds its exit along the lower edge of the bed, but, checked by the increasing imperviousness of the stratum through which it is passing, or by a fold in the beds, or by an earlier ridge against which they abut, accumulates head and flows at the surface of the ground when the overlying confining mass is pierced by a drill. This is the general explanation of the artesian conditions which prevail here. North of the artesian belt the ground water is found at a depth which usually increases inland from the artesian area toward the hills. Near the hills it may lie at depths which preclude pumping at a profit for ordinary crops. South of the artesian area the depth of the ground-water level varies with the topography, being least in the lowest lands and greater in those which are higher.

The ground waters which are not artesian have precisely the same origin as those which exist under pressure. Indeed, they are part of the same subterranean water body, due to rainfall, in part local, in greater part run-off from the higher mountain areas which surround the valleys, whence they flow to the lowlands as winter flood waters.

PERMANENCE OF THE UNDERGROUND WATER SUPPLY.

The decade of dry years through which southern California has passed seems likely to have brought the flow of surface streams down to a minimum, so that those irrigators who depend on the surface

flows and have adjusted themselves thoroughly to this determined minimum have no ground for further concern as to their supply, provided their rights are so thoroughly adjusted legally that rivals can not enter the field and, either by surface diversions or by the installation of wells and pumps, either above or below them, divert their waters.

The supply derived from underground sources is in a less stable and well-adjusted condition. The underground reservoir, which lies along the coastal plain and furnishes the subterranean waters used in the Anaheim and Santa Ana quadrangles (see Pls. VI and VII), is by far the largest and has much the greatest capacity of any in southern California (see Pl. I). It is fed by the flood waters and, to a much smaller degree, by the underground seepage of the three most important streams in this part of the State—Los Angeles, San Gabriel, and Santa Ana rivers. Other less important accessions to its supply are local rainfall, minor drainage from adjacent hills, and return waters from irrigation.

The three largest streams named above, which form the main source of the underground waters, are somewhat less efficient now as agents for the replenishment of the underground supply than before the settlement of the country. All of their normal flow, for some years, has been diverted before it reaches the coastal plain, and an important percentage of the minor floods is used by irrigators along the upper parts of the streams. Only the greater floods reach the lower stretches, and of them a somewhat smaller percentage than formerly escapes absorption by the alluvial fans just below the canyon mouths, because the absorptive capacity of the fans has been increased by their drainage in the search for water for irrigation. The accretions from local rainfall and minor undiverted drainage from near-by hills have not been affected by settlement. They depend upon annual precipitation and vary with it. The accretions from return irrigation waters furnish a source which did not exist before the colonization of the region, but as these are a variable and probably generally a small portion of the extra drafts which man has made upon the underground supply, either by drawing directly from it or by diverting stream waters which would otherwise be added to it, they serve only to reduce slightly the effect of these drafts.

The sum of all these effects must be a notable decrease in the amount of water annually added to the underground reservoirs. Meanwhile there have been extensive drafts made upon them, and these drafts are constantly increasing. There are nearly 3,000 wells in the area under discussion and over 8,000 in the entire coastal plain belt. Of the former, 800 were flowing wells in the spring of 1904, 400 were equipped with power pumping plants, and nearly 900 had windmills over them.

The remainder were domestic wells, whose drafts upon the underground supply are inconsiderable. In the two quadrangles under discussion the total output from the wells that could be measured, or whose owners could furnish definite data as to the yield, amounts to 240 second-feet during the pumping and irrigating season. These figures include the yield both of artesian wells and pumping plants. The pumping season varies with the crop and the rainfall, but usually lasts from fifty to one hundred days. Many of the artesian wells are open the year round, others are capped when not in use, and since in the above computation there were omitted all wells which yield less than 1 miner's inch, all natural springs, of which there are several with a large yield, and a great number of artesian wells which for one or another reason were not accessible for measurement, it is considered well within the truth to estimate the draft of 240 second-feet as continuous for two to three months in the year, equivalent to an annual draft of 40 to 60 second-feet, upon the underground supplies.

The amount of annual withdrawals from underground sources may be estimated in another way. The total area under irrigation on the two quadrangles is about 35,000 acres. On the basis of a duty of 1 miner's inch to from 7 to 10 acres, continuous service, from 70 to 100 second-feet of water would be required for this acreage. As the minimum supply received in this area from the Santa Ana, the San Gabriel, and Santiago Creek is from 30 to 40 second-feet, this estimate leaves 40 to 60 second-feet to be supplied by the underground sources. Neither estimate is very accurate, but as the two are in accord the result may be accepted as being approximately correct.

This means that the water which is being drawn from the underground reservoir in the Santa Ana and Anaheim quadrangles is equal to from one to one and one-half times the minimum flow of Los Angeles River at the headworks of the city canal, or of Santa Ana River at Bedrock Canyon, where the diversion works of the Anaheim and Orange systems are located.

It is estimated that $250,000 is already invested in pumping plants, and the number of these is increasing as rapidly as the machinery can be secured. Many owners of stock in the Anaheim Union Water Company have disposed of their stock and depend upon the underground supply entirely.

The number of wells within the present artesian belt (see Pls. VI and VII) is being rapidly increased also, and with the decrease in pressure and the falling water plane some lands must be irrigated which formerly were sufficiently moist to mature crops without irrigation.

Here, as in other parts of southern California, the effect of the low rainfall of the last decade and the constantly increasing drafts upon the stored waters, is shown in a decreased flow in the artesian wells, a shrinkage of the artesian area, and a lowering of the water table outside of it. The original area of the coastal plain artesian belt was nearly 300 square miles; the present area is less than 200 square miles (Pl. I). Originally, there were about 36 square miles of artesian water-bearing lands in the Anaheim quadrangle; now there are only about 4 square miles in which the water flows (Pl. VI). In the Santa Ana quadrangle the loss has been less because this quadrangle includes the lower and more favorably situated portion of the artesian belt. The original

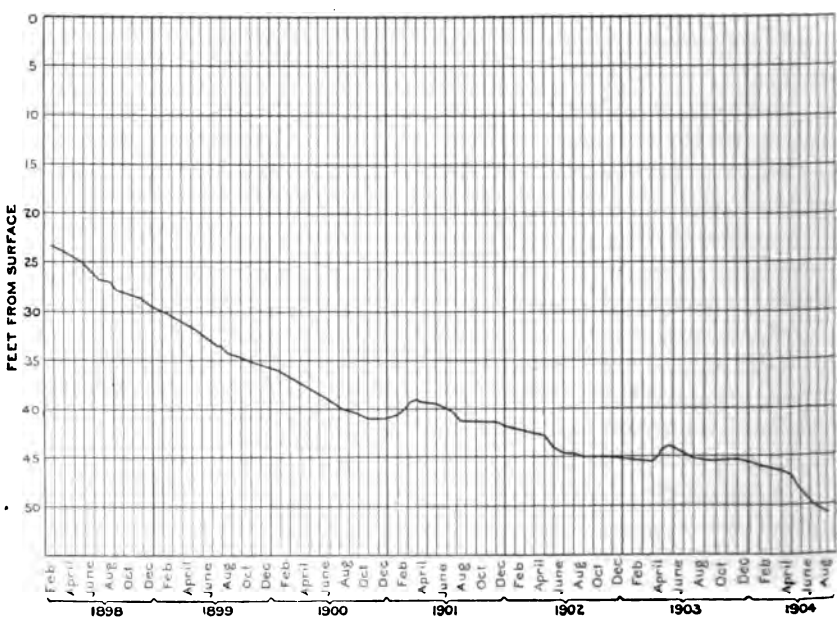

FIG. 2.—Diagram showing variation in water level near Anaheim.

area here was about 70 square miles, and the present area is nearly 57 square miles (Pl. VII).

The effect on the water plane outside of the artesian area is graphically shown in the accompanying profile (fig. 2) which has been prepared from a systematic series of measurements made by Mr. J. B. Neff, on the water level in the wells near Anaheim from which he draws his irrigation water. March 1, 1898, the surface of the zone of saturation in these wells stood 23 feet below the land surface. From this time through the remainder of the dry period, lasting until the fall of 1900, the decline was continuous and very regular, averaging between 6 and 7 inches per month The moderately heavy rainfall of

the succeeding winter (1900–1901) raised the level 2 feet, but the gain was lost by the middle of the following summer, and the decline continued at varying rates until April 1, 1903. During April and May the water level rose 1½ feet, but quickly fell about to the point at which it stood before the spring rains. This level was maintained until January 1, 1904. Since then the water has gone down rapidly because of the dry winter of 1903–4, and the rapid increase in the number of pumping plants, until, on August 1, 1904, it was more than 50 feet below the surface, an average decline of over 4 feet per year since observations began.

Rainfall, in inches, at Anaheim, Cal.

Year.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	Total.
1878–79	0.00	0.00	0.00	0.15	T.	0.95	1.96	0.57	0.85	0.37	T.	0.00	4.35
1879–80	.00	.00	.00	.11	1.72	3.10	1.29	1.82	1.57	2.20	0.00	.00	11.31
1880–81	.00	.00	.00	.28	.44	4.92	.25	.28	.85	.06	.00	.00	7.08
1881–82	.00	.00	.00	.81	.34	.37	.40	1.90	2.42	.48	.40	.00	7.12
1882–83	.00	.00	.00	.26	.78	.00	1.48	1.98	1.22	0.10	2.78	.00	8.60
1883–84	.00	T.	.00	1.12	.00	1.40	2.80	10.58	6.70	1.75	.54	1.28	26.17
1884–85	.00	.00	.00	.15	.64	3.72	.61	.00	.00	.64	.00	.00	5.76
1885–86	.00	.00	.00	T.	2.93	1.16	4.63	.82	2.70	2.51	.00	.00	14.75
1886–87	.00	T.	.00	.00	.33	T.	.43	5.71	.00	2.21	T.	.00	8.68
1887–88	.00	.00	T.	.75	.92	2.16	6.29	.92	5.90	T.	.00	.00	16.94
1888–89	T.	.00	.00	T.	3.75	4.19	.14	1.28	7.97	.24	.57	.00	18.14
1889–90	.00	T.	.76	2.31	.30	10.95	3.36	1.54	.78	.00	T.	.00	20.00
1890–91	.00	.00	.29	.00	.19	3.36	.24	9.05	.59	1.81	.40	.00	15.93
1891–92	.00	.00	.00	.00	.00	1.44	.77	2.35	1.23	.15	1.48	.00	7.42
1892–93	.00	.00	.00	.19	.94	1.48	2.98	2.06	6.07	.23	.00	.00	13.95
1893–94	.00	.00	.00	.00	.30	2.38	.68	.35	.48	.13	.10	.00	4.42
1894–95	T.	T.	.10	.00	.00	5.69	6.92	.68	2.63	.05	.10	.00	16.07
1895–96	.00	.00	.00	.00	.97	.48	3.25	.00	3.03	T.	.00	.00	7.73
1896–97	.00	.00	.00	1.98	1.40	1.59	3.00	4.35	2.20	.00	.00	.00	14.52
1897–98	.00	.00	.10	1.60	.00	.00	1.65	.10	1.00	.20	1.00	.00	5.65
1898–99	.00	.00	T.	.00	.00	.20	2.78	.15	1.61	.20	.00	.51	5.25
1899–1900	.00	.00	.07	1.32	.84	1.45	1.29	.00	.73	1.09	1.49	.09	8.37
1900–1901	.00	.00	.00	.34	4.81	.00	3.50	3.11	.59	T.	2.30	.00	14.65
1901–2	.00	.00	.00	1.34	.50	.00	1.70	3.16	3.20	.11	.07	T.	10.08
1902–3	T.	.00	.00	.40	1.36	3.83	1.22	2.61	5.58	4.47	.00	.00	19.47
1903–4	.00	.00	.38	.06	.00	.00	.19	1.39	3.61	.82	(?)	.00	6.45

Average, 26 years, 11.45.

Rainfall, in inches, at San Bernardino, Cal.

Year.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	Total.
1870-71	0.00	0.00	0.02	0.09	3.11	0.89	6.91	2.21	0.19	0.34	0.11	0.07	13.[illegible]
1871-72	.00	.04	.13	.60	.88	3.91	.00	2.20	.37	.79	.06	.00	8.[illegible]
1872-73	.00	.18	.04	.00	1.17	4.40	6.50	1.25	.51	.84	.21	.00	15.[illegible]
1873-74	.00	1.06	.02	.01	.74	5.73	5.51	8.76	1.08	.48	.42	.00	2[illegible].[illegible]
1874-75	.00	.00	.06	1.82	1.88	2.20	7.20	.15	.22	.07	.05	.00	1[illegible].[illegible]
1875-76	.00	.00	.00	.00	7.50	.02	6.55	1.92	3.41	.44	.03	.03	19.[illegible]
1876-77	.00	.00	.00	.20	.40	.00	3.50	4.03	.83	.26	.30	.00	9.[illegible]
1877-78	.00	.00	.00	.86	.50	3.95	3.33	6.68	2.57	1.71	.66	.07	2[illegible].[illegible]
1878-79	.07	.00	.02	.14	.05	4.70	3.59	1.00	.50	1.20	.24	.03	11.[illegible]
1879-80	.11	.02	.01	.94	3.40	6.50	1.56	1.33	1.45	5.00	.04	.00	2[illegible].[illegible]
1880-81	.00	.00	.00	.14	.67	8.80	1.40	.36	1.66	.46	.01	.00	13.[illegible]
1881-82	.00	.00	.00	.80	.27	.50	1.11	2.65	3.30	2.91	.00	.00	11.[illegible]
1882-83	.00	.00	.00	.10	.15	.45	1.60	1.10	2.82	2.95	.00	.00	9.[illegible]
1883-84	.19	.00	.53	.85	.09	2.63	1.63	12.20	9.95	5.68	3.17	.59	37.[illegible]
1884-85	.00	.00	.00	.00	.11	3.75	2.79	.11	.28	1.89	1.69	.19	10.[illegible]
1885-86	.00	.00	.00	.39	4.36	1.20	6.34	2.52	4.18	2.36	.32	.16	2[illegible].[illegible]
1886-87	.00	.00	.00	.00	.11	.61	.39	6.44	4.41	1.90	.42	.22	14.[illegible]
1887-88	.11	.04	.09	1.17	2.29	1.91	4.01	3.60	3.41	.58	.52	.03	17.[illegible]
1888-89	.00	.00	.00	.05	4.12	4.64	.93	1.50	6.55	2.05	1.13	.00	2[illegible].[illegible]
1889-90	.17	.63	.11	2.30	2.23	10.85	5.44	2.52	.89	.00	.31	.00	2[illegible].[illegible]
1890-91	.13	2.16	.88	.58	1.27	3.02	.00	7.78	.06	.53	1.67	.00	1[illegible].[illegible]
1891-92	.00	.91	.93	T.	T.	1.67	3.24	3.30	1.75	.37	2.10	.08	14.[illegible]
1892-93	.00	.00	.00	.16	1.02	2.23	4.53	3.37	8.00	.48	.03	.00	19.[illegible]
1893-94	.20	.00	.05	1.05	.30	2.28	1.26	.88	1.15	.40	.56	.00	8.13
1894-95	.00	.16	.37	.15	.00	7.25	7.39	1.14	3.44	.64	.44	.00	2[illegible].[illegible]
1895-96	.00	.00	.00	.00	1.14	.66	2.02	.00	2.92	.37	1.00	.00	[illegible]
1896-97	T.	.17	.00	2.10	.98	1.09	3.40	5.40	3.41	.08	.11	.00	16.74
1897-98	T.	.00	.13	2.10	.21	.57	2.10	.60	.97	.48	1.08	.00	[illegible]
1898-99	.00	.00	.00	.03	.05	.44	2.03	.51	3.22	.07	.19	.95	7.[illegible]
1899-1900	.00	T.	.01	.81	1.47	.84	.92	.00	.92	1.96	1.71	.00	[illegible].64
1900-1901	.34	.00	.23	.36	6.10	.00	3.48	4.58	.43	.56	1.23	.05	17.[illegible]
1901-2	.00	.27	.07	1.09	.28	.04	1.65	3.02	3.89	.57	.12	.15	11.15
1902-3	.01	.00	.00	.09	1.94	1.94	1.96	1.67	6.47	3.10	.24	.00	17.[illegible]
1903-4	.00	.15	.46	.07	.00	.00	.18	2.21	5.34	.80	.16	.00	9.[illegible]

Average, 34 seasons, 15.06.

In order to determine the relative weights of excessive development and deficiency in rainfall in bringing about this effect, rainfall tables are given and charts presented in whch the excess and deficiency of rainfall for a period of years at Anaheim and at San Bernardino are shown (figs. 3 and 4).

Since the coastal plain basin is supplied chiefly by the drainage from Los Angeles, San Gabriel, and Santa Ana rivers, its water supplies are affected more by the rainfall within the San Gabriel and San Bernardino mountain ranges than by local rainfall. A composite

record, compiled from local records in each of these valleys and at various points within the coastal plain, would furnish the most satisfactory basis for comparison, but since excessive rainfall in one part

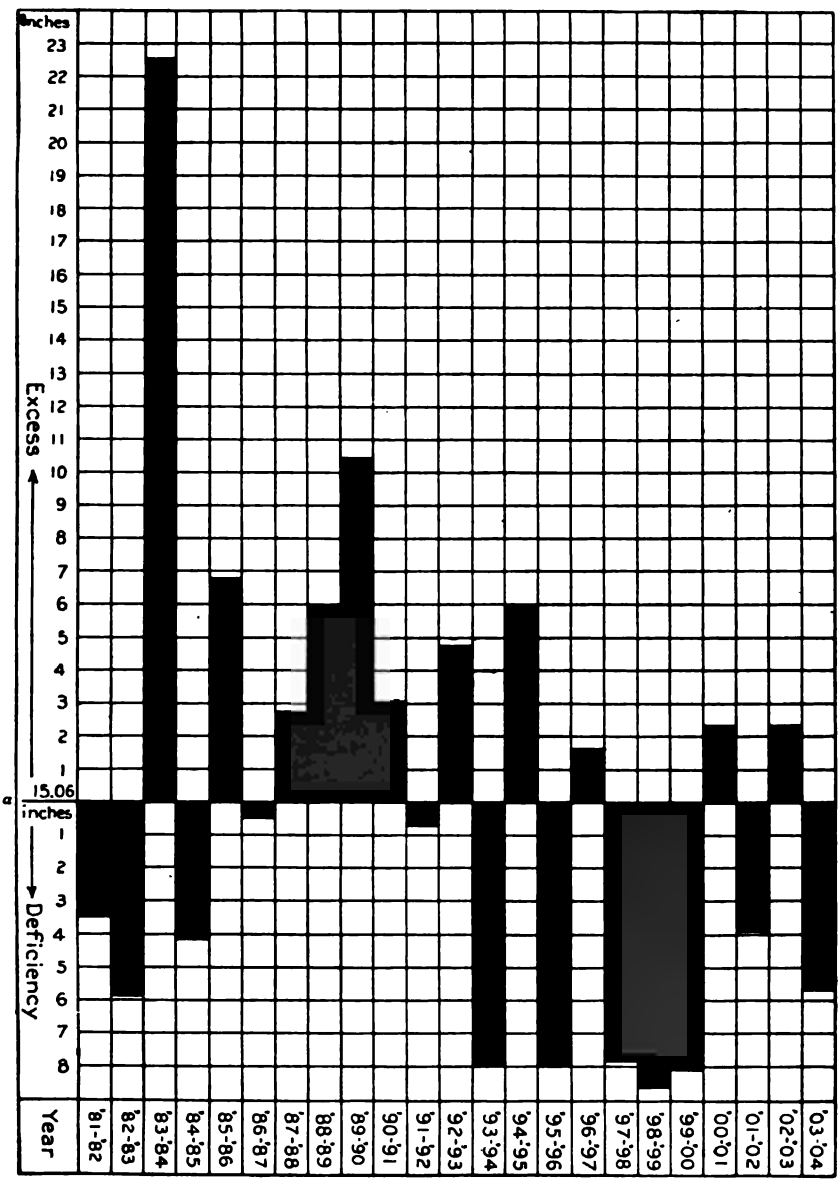

FIG. 3.—Chart showing departures from average rainfall at San Bernardino, Cal. [a] Average for 34 years (15.06 inches).

of southern California generally means excessive rainfall in other parts, although the absolute quantity at various points may differ greatly, the percentage of variation from the average at any point

may be assumed to be nearly equal to the percentage of variation from the average at other points.

By preparing charts, as those from San Bernardino and Anaheim are prepared, the departure from the average for each year is brought out instead of the total precipitation. It is thus seen at a glance whether the rainfall for any particular season is above or below the general average. Such charts are especially valuable for comparison with a profile like that of Mr. Neff's (fig. 2).

The underground waters should not be withdrawn faster than they

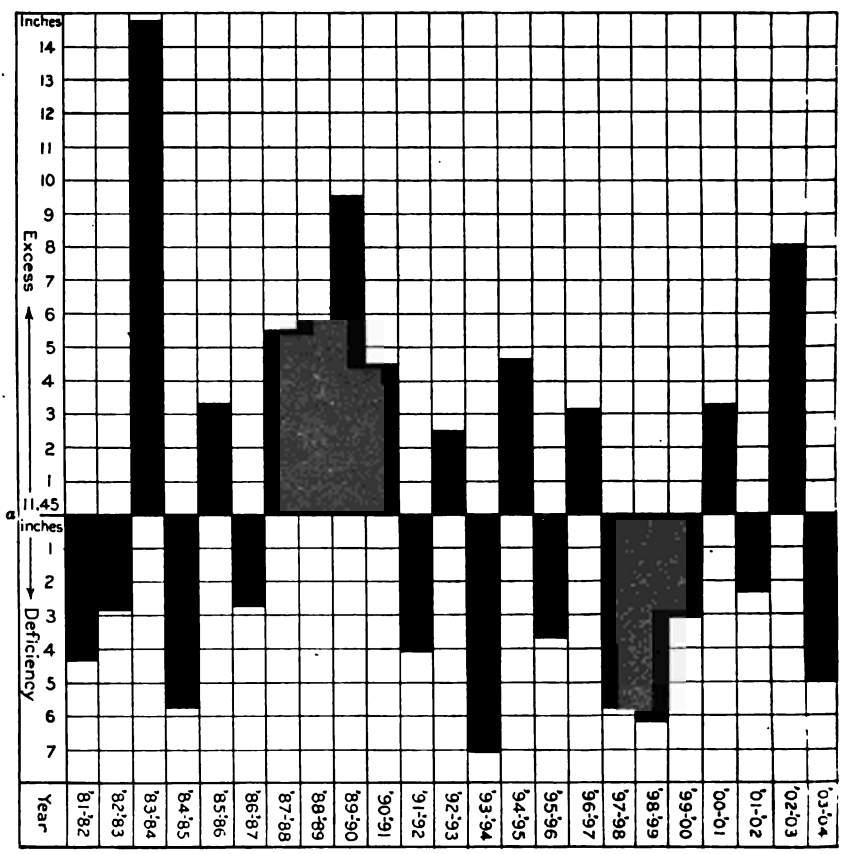

FIG. 4.—Chart showing departures from average rainfall at Anaheim, Cal. a Average for 26 years (11.45 inches).

are restored during years of average rainfall. In a conservative use of these stored waters, as regulating reservoirs and reserve supplies, they will of course be drawn down during years of deficiency in rainfall, but will recover during years of excessive precipitation. If the water plane continues to decline when the precipitation is above the average, and fails of restoration during years of great excess it means that a permanent lowering is taking place, whose rate may be expected to increase with further developments.

In the Neff wells the decline was sharpest, as should be expected, in the years of great deficiency which preceded 1901. The rainfall that winter, which was over 2 inches above the average in San Bernardino and somewhat more than 3 inches above the average at Anaheim, produced a temporary rise in the profile representing the Anaheim water level, but that rise was lost before the end of the succeeding August, proving that with the drafts at that time made upon the underground water bodies, a rainfall above the average was not sufficient to restore the waters annually taken out.

After this winter of excessive precipitation the decline was continuous, although not at a uniform rate, through the succeeding dry year, until early in 1903, when, in response to another year of increased rainfall, the water level rose about 1½ feet, but this effect had passed and the water level had fallen about to the level of the previous autumn, by August 1. The winter of 1903–4 was again a winter of marked deficiency and in the region about Anaheim there was a very rapid installation of pumps. In consequence, the water level declined during the spring of 1904 as rapidly as at any time since observations began, and on August 1, 1904, passed below the 50-foot level.

The significant point about these declines is that they have continued through years of more than average rainfall, although every foot of decline decreases pressure and yield of flowing wells and stops the flow of some wells entirely, thus tending to reduce the drafts. Evidently, the rapid increase in the number of wells more than offsets the decrease in individual yield, so that the constant effect is an increase in the total amount of water withdrawn. Eventually the falling water plane will cut off so many flowing and pumped wells that the drafts will no longer be in excess of the supply, and the water plane will then remain stationary. But that point will be permanently lower, and if drafts continue to be increased it may be much lower than the original ground-water level. Where it is finally fixed depends upon the water users themselves. One thing is certain, more water can not be continuously drawn from a reservoir of any sort than is supplied to it, and it is clear that more is now being taken from this portion of the coastal plain than is being added by natural processes. The water level therefore will continue to fall until by falling it has reduced the drafts until they are no longer in excess of supply. A series of years of heavy rainfall, which are earnestly hoped for by water users throughout southern California, would partly fill the depleted reservoirs, partly restore the original water level, brace the now tottering belief that the underground water resources are inexhaustible, and encourage further unwise development, so that when average conditions returned the decline would be more rapid than at present, and much harm would result. As a matter of fact,

the present cycle of dry years, coming thus early in the agricultural development of the region, will, if it continues long enough to call attention to the earnest need of conservation of subsurface supplies, be a scarcely disguised blessing. The general complaint, which one hears everywhere, of a scarcity of water means an awakening realization of the need of care, and is thus a most favorable omen. A public sentiment should be created which would make it impossible for any individual to use his water supplies carelessly, to leave artesian wells uncapped and flowing freely when the water is not needed, or to use upon his soil more than the necessary amount, and a further sentiment should be created unfavorable to the continued sinking of wells and installation of plants. This is much more difficult to create, because the bringing of more acreage under cultivation and the employment of capital and labor in such enterprises are regarded as general contributions to the prosperity and welfare of the section, and are welcomed accordingly. If, however, it is clearly understood that each additional plant thus installed is to a degree at the expense of those already in existence, since it contributes to the rapidity with which the water plane is lowering and to the expense, therefore, of lifting irrigation water, sentiment will change in this matter and it will be realized that it is better to protect the vested interests than to sacrifice these for a temporary increase in industrial activity.

In a region where underground water supplies are as important as here, and at the same time so liable to unwise overdevelopment, it may eventually be necessary to create a State commission with power to grant or to refuse to grant permits for drilling wells or installing pumping plants. Individual wishes and individual needs are scarcely to be trusted in matters which so vitally affect the community and the State at large. Especially is this true because it is just those landowners whose wells are most favorably located who, having an abundance of water themselves, do not realize the scarcity at other points, and drain away the water most rapidly from their less favorably situated neighbors.

INTERDEPENDENCE OF WELLS.

In general each well in the coastal plain, whether flowing or pumped, affects every other well in the same region. Widely separated wells will not have a measurable effect upon one another, the actual effect being too small for observation. All drain from a common source, the body of saturated sands and gravels which underlie the wide plain between the Puente Hills and the sea—and whatever reduces the amount of water in that body of alluvium affects all wells which draw from it.

The wells on the lowest ground are always most advantageously situated when the source of water is common to all, and there is no impervious obstruction to interfere with free circulation. These lower

wells affect the higher ones more than they are affected by them, the mutual effect thus differing in degree.

In the artesian area, where the water, in its slow movement toward the sea, has passed below strata of nearly impervious clay, strong flows may often be obtained from deeper horizons whose confining stratum extends farther inland and whose pressure therefore originates at a higher point, after shallow wells have ceased to flow. The yield from such a deeper well will usually be less than if it had been drilled before the shallow well failed, because its pressure has also been affected by the general lowering of the water plane; hence a degree of interdependence exists even between those water horizons which are separated by clay lenses.

This fact of interdependence may mean that users of underground waters in the coastal plain region are rivals; it should also mean that they have a common interest in preventing waste and conserving their supplies.

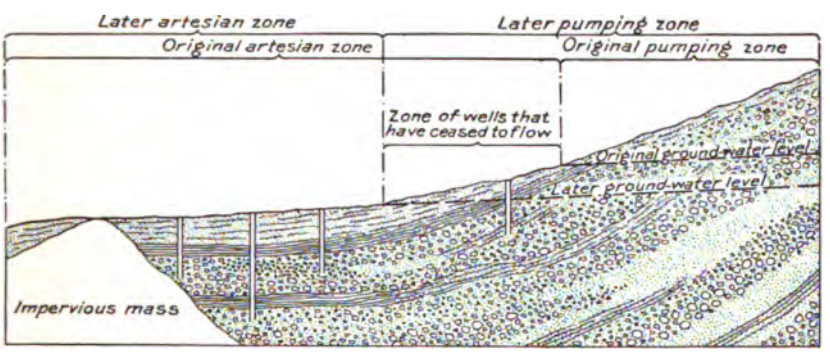

FIG. 5.—Diagrammatic cross section of southern California coastal plain.

COST OF WELLS.

As guides to the cost of wells the following tables of approximate charges for boring have been prepared from figures furnished by Messrs. Cunningham, Raines, Schantz, and Burrows, who have had much experience as well drillers in the Santa Ana region. The figures given by responsible drillers accord closely, the difference being due to local conditions or to the custom in one neighborhood of making an average estimate for a number of hundred feet, while in another this average may be split up into specific rates for integral parts of the total.

In the following table the price of drilling the first hundred feet and the additional price for each 50-foot increase in depth are given for the diameters generally used in this region:

Cost of drilling wells.

	4 inch.	5 inch.	6 inch.	7 inch.	8 inch.	9¼ inch.	10 inch.
	Per ft.	*Per ft.*	*Per foot.*	*Per foot.*	*Per foot.*	*Per foot.*	*Per f*
First 100 feet	$0.30	$0.30	$0.35 to $0.40	$0.40	$0.40 to $0.50	$0.60 to $0.65	$0.[illegible]
Additional for each 50-foot increase	.25	.25	.20 to .30	.20 to .35	.20 to .35	.20 to .35	.3[illegible]

For hydraulic wells the charge is 30 to 40 cents per foot, the diameter 2 to 4 inches and the depth usually less than 100 feet.

The Baker Iron Works, of Los Angeles, have furnished the following general price per foot for riveted steel casing made up into 2-foot joints of the sizes and gages generally used for wells. Such prices will vary with the steel market, so that constant minor departures from them are to be expected.

Cost of well casing.

Diameter.	Gage.	Price per foot.	Diameter.	Gage.	Price per foot.
Inches.			*Inches.*		
4	16	$0.32	9½	14	$0.75
4	14	.38	9½	12	.94
5	16	.35	10	16	.68
5	14	.43	10	14	.78
6	16	.42	10	12	.98
6	14	.50	12	14	.80
7	16	.48	12	12	1.10
7	14	.55	12	10	1.40
8	16	.55	14	12	1.30
8	14	.64	14	10	1.55
8	12	.78	16	12	1.55
9½	16	.65	16	10	1.70

For riveting starters the charges are from 20 to 25 cents per foot extra.

Rings range through about the following prices:

Cost of rings.

4 inch	$2.75
5 inch	3.50
6 inch	4.00
7 inch	5.00
8 inch	6.50
9 inch	7.00
10 inch	10.00
12 inch	12.00
14 inch	17.00
16 inch	20.00

In the artesian belt hydraulic wells of 2 or 3 inch diameter are often put down, and the standard pipes for these cost, respectively, 15 and 25 cents each per foot.

DESCRIPTION OF MAPS AND TABLES.

The maps presented with this report show (*a*) the areas irrigated in the spring of 1904, when the field work was done (Pls. II, III), (*b*) the pumping plants and distributing systems by which the water is secured and conducted to the land where it is used (Pls. II, III), (*c*) the areas of artesian water-bearing land at the beginning of 1904, and the original artesian area (Pls. VI, VII), (*d*) the zones of relative alkalinity in the underground waters (fig. 6), and (*e*) the elevation of the planes of saturation outside of the present artesian belt (Pls. VI, VII). Where the data are sufficient the elevation of the plane of saturation is shown by means of contours. The elevations used in determining the position of this plane are those furnished by the topographic sheets, which serve as bases for the maps. It is to be regretted that these elevations are somewhat inaccurate, as the sheets were prepared ten years ago, before modern refined topographic methods were in vogue; hence the hydrographic contours themselves are not exact as to absolute elevations. However, they are believed to show, with fair accuracy, the relation of the water level to the topographic contours as the latter are drawn. This is the essential thing, since it enables the user of the maps to tell the distance to the water plane by the difference between the elevations shown by the two sets of contours. Another matter for regret is that these contours have but an ephemeral value as practical guides in developing water. With the water plane lowering at a rate of from 0 to 5 feet per year, the depth to it, as recorded by these maps, will soon cease to be correct. But as records of the position of the water plane in the early part of the year 1904, they will always have interest and will serve as a basis for comparison in later years.

On the mesa lands, and in areas generally where the wells are few and the water plane is irregular, sufficient data do not exist to show its position by contour. In these cases the water elevations at the individual wells visited are shown in purple-blue figures, the positions of the wells in the same color, and the numbers of the wells in black.

From the determinations, by means of the electrolytic bridge, of the amounts of salts carried in solution in the waters, a map (fig. 6) has been prepared upon which waters with equal mineral contents are grouped in zones. The boundaries separating these zones are not sharp, but the grouping brings out the general fact that in the vicinity of the bed-rock hills of Tertiary shale and sandstone, which are impregnated with alkaline salts, the ground waters are distinctly more alkaline than at a greater distance, where they are derived chiefly from

the floods of the larger streams. The purer waters of the lowlands, too, make distinct bays in the less pure hill waters, and the position of these bays is so related to the surface channels of Santa Ana River and Santiago Creek as to suggest that they mark the position of the most rapid underground percolation from these streams, as sources, toward the artesian areas below.

On the maps showing the wells (Pls. VI, VII), those that were flowing at the time the field work was done are given a distinctive symbol, as are those on which pumping plants are installed, when the water

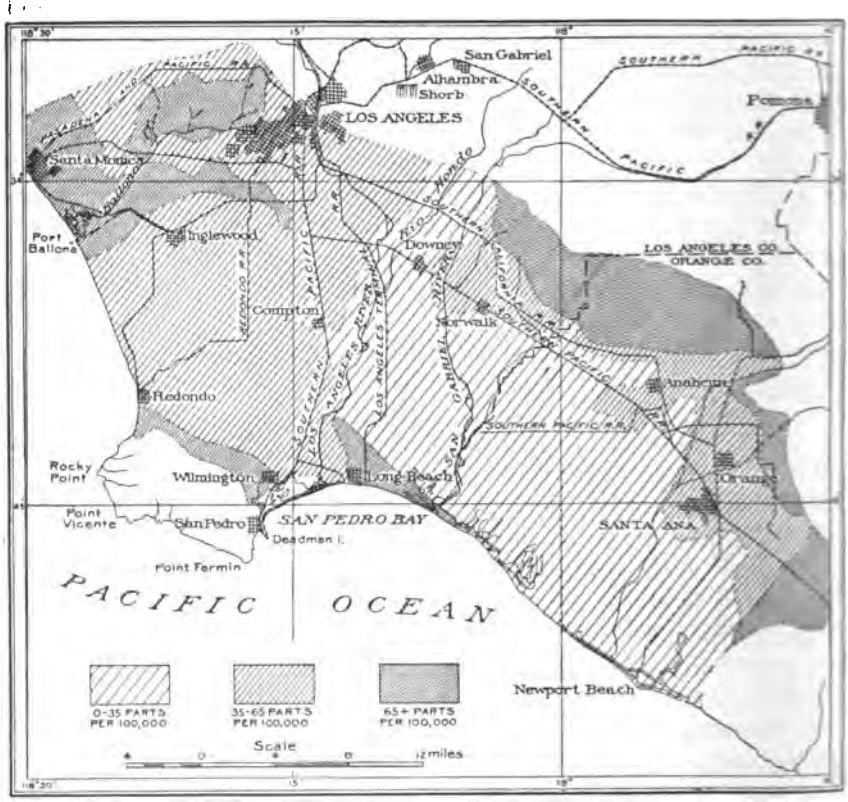

FIG. 6.—Map showing approximate amounts of dissolved solids in the underground waters of the eastern part of the coastal plain of southern California.

thus pumped is used in irrigation. The flowing wells will rapidly decrease for a time in number and yield, it is expected, and the pumping plants are increasing in number with equal rapidity.

Each well is numbered on the map, and in the tables the essential facts concerning it are given under the same number. Where it has been possible to secure definite data, the cost of the well and of the machinery is given.

Where wells were flowing or pumped and were accessible for measurement, the yield is given in the table; in other cases, where it was not possible to make independent determinations, statements of operators of pumping plants were taken.

The approximate proportion of salts in the water—that is, its alkalinity—was determined by the electrolytic bridge and the result appears in one of the columns. These results have also been generalized in the map (fig. 6) already referred to. In most cases they should be correct within three or four parts per 100,000; greater refinement is not possible with the rapid methods used. All the deep wells in the area furnish excellent potable waters, and of course they are thoroughly safe for irrigation. An occasional shallow well shows a much higher degree of alkalinity, due probably to a source too near the surface in alkaline soils. Near the coast, also, some wells are quite brackish, and generally the mesa waters, and those nearer the foothills, composed of alkali-bearing rocks, show the effects of their environment.

Under the heading "Map location," a letter and a number appear. The map has been divided into rectangles which are lettered horizontally and numbered vertically. This column tells at once in which of the rectangles the well is to be sought, and enables any number on the map to be readily found. The other columns in the table are self-explanatory.

ACKNOWLEDGMENTS.

The field work in the Anaheim quadrangle has been done almost entirely by Mr. A. J. Fisk, jr., Mr. E. R. Furstenfeld assisting for a short period.

Mr. A. P. McCarton has collected the greater part of the information embodied in the Santa Ana maps and tables, Mr. W. N. White being responsible for a small portion.

In securing information concerning the greater irrigating systems, the officers of the companies have been appealed to and have responded with unfailing courtesy. Mr. Mansur has supplied data as to the practice under the Santa Ana Valley system, and Mr. Sherwood, representing the Anaheim Union Water Company, has responded to inquiries about that system. Sketches of the Carpenter and Serrano companies, deriving their waters from Santiago Creek, have been furnished by Mr. Helwig and Mr. Collins.

Well drillers generally have answered queries as to phases of the work in which they are most interested, and Mr. E. C. Cunningham, of Santa Ana, in particular, has been reliable and obliging in these matters.

The office work involved in compiling the tables from the field records and in preparing the maps for publication, has been done largely by Mr. A. J. Fisk, jr.; assistance here has also been rendered by Mr. W. N. White.

Wells in the Anaheim quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
51	Mrs. H. Bower	Santa Ana	G-16	1904	Dug, 7-foot diameter, 42 feet; bored, 10-inch, 150 feet.	127	85	192	55	....	Gas	$325.00	$1,150.00	Irrigation	59
52	Geo. Slocum	do	H, G-16	1886	Bored, 6-inch	134	90	60	70	63	Wind		+350.00	Domestic	
53	Mrs. N. Young	do	H, G-16	1884	Bored, 7-inch	137	93	60	42	61	do		+400.00	do	
54	C. C. L. Leslie	do	G-16	1885	do	133	93	47	68	63	do			do	
55	E. Rurup	do	G-16		do	138	93	48	47	64	do			do	
56	M. E. Helme	do	H-17		do	138	96	44							
57	W. W. Halesworth	do	H-17	1885	do	136	97	55	54		Wind	75.00	+1,300.00	Domestic	
58	Geo. W. Ford	do	H-17	1889	do	132	77	125	40		do	150.00	+300.00	Domestic; stock	
59	Mrs. B. M. Edgers	do	H-17		do	136			48		do			Domestic	
60	Ransom Reid	do	H-17		Dug, 8 by 8 foot	135	81	70							
61	Mrs. A. W. Greenwald	do	H-17	1893	Bored, 7-inch	132	92	55	47		Wind	60.00	60.00	Domestic; stock	
62	E. D. Whittlesey	do	H-17		do	137	94	55	52	62	Hand			Domestic	
63	Mrs. M. E. Martin	do	H-17	?1878	do	138	93	55	70	61	Wind			Domestic; stock	
64	E. F. Greenleaf	do	H-17	1882	Bored, 6-inch	133	95	53	52	63	do			Domestic	
65	O. H. Greenwald	do	H-17	1902	Bored, 7-inch	132	92	60	46	62	Hand	60.00	10.00	do	
66	Sarah A. Ross	do	G-17	1882	do	129	95	78	80	63	do	80.00		do	
67	H. Diers	do	G-17	1900	do	127	100	52	89	62	Wind	60.00	+300.00	do	
68	E. A. Clardy	do	G-17	1908	do	123	97	48	95	63	Hand	*65.00		do	
69	F. L. Bundy	do	G-17	1900	do	119	90	123	39	65	Wind			do	
70	Wm. Keely	do	G-17		Bored, 5-inch	120			39		do			do	

71	U. J. Ross	do	G-17	1888	Bored, 7-inch	119	95	57	47	66	Hand			do		
72	G. D. Lillie	do	G-17		do	116			47		Wind			do		
73	Fred A. Marks	do	G-17	1880	do	110	90	55	35	66	do			Domestic; stock		
74	A. E. Hawley	do	G-17	1888	do	108	90	63	35	66	do			Domestic		
75	E. S. Nash	do	G-17	1888	do	103	82	87	50	65	do			do		
76	T. L. Scudder	do	G-17	1902	do	99	79	84	50	65	do	85.00	+150.00	Domestic; stock; irrigation.		
77	S. G. Cooper	do	G-17	1880	Bored, 10-inch	104	84	80	50	65	do			Domestic		
78	S. P. McNeal	do	G-17	1880	Bored, 7-inch	113	92	64	19	63	do	100.00	+400.00	do		
79	J. C. McCaul	do	G-17	1902	Bored (2), 7-inch	116					Gas		2,500.00	Irrigation		†110
80	do	do	G-17	?1888	Bored, 7-inch	111			55		Wind			Domestic; stock		
81	do	do	G-17		Bored, 10-inch	110			40	63	Hand			Stock		
82	W. G. Neville	do	G-17		Bored, 7-inch	117	98	94	52		Wind			Domestic		
83	Van Horn	do	G-17		do	108	96	23	51	62	Hand			do		
84	Peter Rassmusen	do	G-17	1903	do	108	96	65	44	65	do	135.00		do		
85	R. R. Raymond	do	G-17	?1882	Bored (2), 7-inch	127	107	45	60		Wind	100.00	+100.00	Domestic; stock		
86	do	do	G-17	?1882	Bored, 7-inch	123	103	175			Hand	200.00	15.00	Stock		
87	J. C. Kirby	do	G-17	?1882	do	130	110	45	51	64	do			Domestic		
88	L. A. Greenleaf	do	G-17	1897	do	132	111	119	42		Wind	80.00	+200.00	do		
89	J. Steward	do	G-16		do	120			38		do			do		
90	Right & Barcus	do	G-16		do	125	75	65	44		do			do		
91	J. A. Smiley	do	G-16	1902	do	136	94	56	49		do	55.00	30.00	do		
92	S. P. Co	do	G-16	1900	do	137	92	52	45	68	Hand			do		
93	M. Witt	do	H-16	1901	do	148	108	155	39		Wind	275.00		do		
94	T. L. Kling	do	G-15, 16	1892	do	127	93	43	22	67	do			Domestic; stock		
95	J. W. Berry	do	G-16		do	130	97	43	87	66	Hand			Domestic		
96	A. R. Kelsey	do	G-15	1898	do	136	92	48	42	68	Wind	25.00	+150.00	Domestic; irrigation.		
97	Fred Schlueter	do	G-15		Dug, 3 by 3 foot	127	98	42	56	63	Hand			Domestic; stock		
98	Mrs. Martha Shaffer	do	G-15	1884	do	137	99	40	42		Wind			Domestic		
99	W. T. Walton	do	G-15	1896	Dug, 4 by 4 foot	133	95	40	48	60	Hand			do		
100	T. B. Laidley	do	G-15	1902	Bored, 6-inch	133	91	60	56	62	do	*100.00		do		
101	Mrs. Martha Shaffer	San Juan Cajon	G-15	1902	Bored, 10-inch	127	82	88			Gas			Irrigation		
101a	do	do	G-15	1902	Bored, 9½-inch	127	82	330			do	*1,250.00		do		†114
101b	do	do	G-15	1902	Bored, 7-inch	127	82	200			do			do		

Wells in the Anaheim quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
102	Mrs. Martha Shaffer	San Juan Cajon	G-15		Bored, 7-inch	127		70			Wind			Stock	
103	M. C. Cuddeback	Santa Ana	G-15	1898	Dug, 3 by 3 foot	133	91	43	49		do			Domestic	
104	Otto Hoffman	do	G-15		do	130	88	44	47	61	Hand			do	
105	Thos. H. Brown	do	G-15	1903	do	144		44			do			do	
106	do	do	G-15		do	148	101	48	47	64	do			do	
107	J. L. Sanborn	do	H-15		Bored, 7-inch	149		80	44	62	do			do	
108	do	do	H-14, 15	1885	do	152	102	80	47	62	Wind			do	
109	John C. Keefe	do	H-14		do	154	101	54	53		do			Domestic; stock	
110	R. A. Adams	do	H-14	1898	Dug, 3 by 3 foot	157	107	60	49	64	Hand			Domestic	
111	do	do	H-14	1900	Bored, 7-inch	163	108	105	29		Wind	$150.00	+$300.00	do	
112	John Bendick	do	H-15	1883	Bored, 8-inch	161	105	59	35	66	Hand	150.00	50.00	do	
113	G. Enechel	do	H-15		Dug, 2½-foot diameter.	159	100	85	41		Wind			do	
114	Geo. Dierker	do	H-15	1897	Bored, 7-inch	158		70	34	67	Hand			do	
115	John A. Irvine	do	H-15		do	163	92	79	37	62	Wind			do	
116	J. D. Parker	do	H-15	1874	do	155	96	75	38		do			do	
117	J. V. Green	do	H-15		do	160	97	78	37	69	Hand			do	
118	Mrs. E. Dreyer	do	H-15	1898	do	162	95	90			Wind			do	
119	E. Meehan	do	H-15	1897	do	163	123	88	39	67	do			do	
120	W. H. Burnham	do	H-15	1894	do	172	112	126	38	61	do	100.00	60.00	do	
121	do	do	H-15	1889	Bored, 10-inch	173	113	124	38	61	do	125.00	75.00	Domestic; irrigation.	
122	do	do	H-15	1893	Bored, 7-inch	173	113	122	38	61	Gas	100.00	450.00	do	

123	Mrs. Martha Ronty	do	I-17	1882	do	148	74	104	39	58	Hand			Domestic		
124	Thos. Morris	do	I-17	1884	do	170	108	90	39		Wind			do		
125	J. A Booty	do	I-17		do	170	96	150	39		do			do		
126	A. E. Marshall	do	I-17	1901	Dug, 3 by 3-foot	185		85	53	61	Hand			do		
127	A. Deventier	do	I-17	1894	Bored, 7-inch	170	107	93	49	63	Wind	175.00		do		
128	F. S. Buchheim	do	I-17	1894	do	169	97	80	53	61	do			do		
129	K. Claaver	do	I-17	1903	do	167	107	140	36	64	Hand	235.00	22.00	do		
130	R. H. English	do	F-17		Bored, 10-inch	82	62	50	35		Wind			Domestic; stock		
131	do	do	F-17	1903	do	77	57	187								
132	G. A. Clark	Las Bolsas	F-17	1901	Driven, 2-inch	75	57	40	52	62	Hand			Domestic		
133	A. N. Van Nest	do	F-17	1897	Driven, 1¼-inch	78	72	14	78	62	do			do		
134	J. H. Young	Santa Ana	F-17	1904	Dug, 4 by 4-foot	83	63	23		62	do			do		
135	Ben Clarke	do	F-17	1903	Driven, 1¼-inch	76	66	19	36	64	do		7.50	do		
136	W. E. Ward	Las Bolsas	F-16, 17		Bored, 7-inch	101	80	90	35		Wind			do		
137	L. F. Marsile	do	F-16	1880	Bored, 4-inch	103	81	140	91	68	Hand			do		
138	do	do	F-16	1902	Bored, 10-inch	104	81	94	26		Gas		1,650.00	Irrigation		†80
138a	do	do	F-16	1903	Bored, 7-inch	104	81	94	26		do					
139	J. H. Belt	do	F-16	1888	Bored, 4-inch	105	85	87	34		Wind			Stock		
140	do	do	F-16, 17	1899	Bored, 7-inch	101	81	136	32	62						
141	B. F. Wolfe	do	F-16	1903	do	100	80	93	34	62	Hand	100.00	15.00	Domestic		
142	M. Atgen	do	F-17	1890	do	77	67	80	29		Wind			Domestic; irrigation.		
143	do	do	F-17	1901	Driven, 2-inch	77	71	17	78	62	Hand			Stock		
144	John Cudderback	do	F-17	1902	Bored (2), 7-inch	79	66	110			Gas		800.00	Irrigation		†60
145	Mrs. Clapp	do	F-17	1889	Bored, 7-inch	83	71	100	27		Wind			Domestic		
146	do	do	F-17	1898	Driven, 2-inch	80	72	14	78	62	Hand			Stock		
147	J. E. Brown	do	E-17	1892	Bored, 7-inch	77	65	157	35	63	Wind		+125.00	Domestic; irrigation.		
148	R. E. Beswick	do	E-17	1903	Driven, 1¼-inch	73	60	22	40	63	Hand			Domestic		
149	D. D. Armes	do	E-17	1888	Bored, 4-inch	70	54	147	33		Gas			Domestic; irrigation.		
150	J. Killefer	do	E-17	1902	Driven, 2-inch	70	62	110	29	65	Hand	*54.00		Domestic		
151	Otto Buell	do	E-17		Bored, 7-inch	69		150	43		Wind			Domestic; irrigation.		
152	E. D. Music	do	E-17		do	70	56	125	33	64	Hand			Domestic; stock		
153	Wm. Shearer	do	E-17		Bored, 4-inch	68	59	160	29		Wind			Domestic		

Wells in the Anaheim quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
154	Jessie Davis	Las Bolsas	E-17	1892	Bored, 7-inch	69	57	370	22	63	Wind	$1,000.00		Domestic	
155	do	do	E-17	1889	do	69	57	180			do	230.00			
156	J. Q. Adams	do	E-17	1879	Bored, 3½-inch	65	58	156	27	65	do			Domestic; irrigation.	
157	J. E Shrode	do	D-17	1890	Bored, 4-inch	68	56	140	27	64	Hand			Domestic	
158	J. Wertz	do	D-17	1898	Bored, 7-inch	66	55	167	25		Wind			Domestic; irrigation.	
159	L. L. Bailey	do	D-17		Bored, 4-inch	62	60	117	25	63	do			do	
160	J. Q. Johnson	do	D-17	1880	Bored, 7-inch	50	49	135	26	63	do			Domestic	
161	do	do	B-17	1900	do	50	49	151			Gas			Irrigation	†100
162	do	do	B-17	1898	Bored, 4-inch	51	51		31	64	Artesian			do	
163	do	do	B-17		Hydraulic, 2-inch.	47	49	148	31	64	do			do	4
164	do	do	B-17		Bored, 7-inch	46	49	148	31	64	do			do	
165	W. W. Thayer	do	E-17		Driven, 2½-inch	70			32	62	Wind			Domestic; irrigation.	
166	A. C. Chandet	do	E-17	1902	Bored, 7-inch	70	62	127	37		Gas	123.00	$325.00	Irrigation	†45
166a	do	do	E-17	1902	do	70	62	135	37		do	123.00		do	
167	Geo. Davis	do	D, E-17		Bored, 4-inch	72	64	90	30		Wind			Domestic	
168	M. Beswick	do	D-17	1892	Driven, 2-inch	70	58	60	27		do			do	
169	J. T. Wallace	do	D-17		Bored, 4-inch	72			31	63	Hand			do	
170	J. M. Hunnington	do	D-17	1890	do	70	60	101	31	63	do			do	
171	H. Hudson	do	D-17		Bored, 7-inch	70	58	115	32		Wind			do	
172	G. H. Mills	do	C-17	1872	do	58	61	100	26	65	do			Domestic; stock	

173	do	do	C-17	1903	do	76	68	207				300.00		Not used	
174	do	do	C-17	1904	do	71	68	135	29	64	Gas	850.00	850.00	Irrigation	†125
174a	do	do	C-17	1904	do	71	68	166	29	64	do				
176	F. H. Teel	do	D-17	1890	Bored, 4-inch	65	52	158	29	65	Wind			Domestic; irrigation.	
177	Mrs. W. H. Morgan	do	D-17	1896	do	62		145	31	65	Hand			Domestic	
178	H. W. Davis	do	C-17	1882	Bored, 7-inch	51	51	90	28	64	do			do	
179	do	do	C-17	1882	do	52	51	150	28	62	Gas		550.00	Irrigation	
180	W. N. H. Evans	do	C-17		do	62	58	90	31	64	Hand			Domestic	
181	do	do	C-17		do	60	58	150	31	64	do			Stock	
182	J. S. McKee	do	C-17		do	61	54	129	29	63	do			Domestic	
183	J. H. Carlyle	do	C-17		do	64	56	210			Wind			Not used	
184	do	do	C-17	1882	do	64	56	140	25	63	do			Domestic	
185	J. P. Weinechank	do	B-17		do	52	48		31	64	do			Domestic; irrigation.	
186	S. R. Holdeman	do	C-17	1882	do	58	55	152			Gas		675.00	Irrigation	†50
187	do	do	C-17	1889	do	55	53	154	31	64	Hand			Domestic	
188	A. O. Thompson	do	B-17	1882	do	49	49	103	30	64	Artesian			Stock	
189	J. C. Thompson	do	B-17	1882	do	47	47	65	25	63	do			Domestic	
190	R. R. Overlander	do	B-17		do	49	49	123	27	62	Gas		400.00	Irrigation	
191	J. Magenty	do	B-17	1898	do	49	49	147	27	62				Not used	
192	do	do	B-17	1890	Bored, 4-inch	49	49	148	28	62	Hand			Domestic	
193	D. M. Watts	do	B-17	1878	Bored, 8-inch	48	48	90	26	61	Wind			Stock; irrigation	
194	Lee Mahan	do	B-17		Bored, 4-inch	48	48	103	27	61	Hand			Domestic	
195	J. L. Carpenter	do	B-17	1892	Bored, 7-inch	51	49	155	29	65	Wind			do	
196	R. E. Blakey	do	B-17		do	48	48	121	27	64	Artesian			Not used	3
197	do	do	B-17		do	48	48	118	27	64	do			Domestic	1
198	W. A. Parmel	do	C-17	1897	do	65	54	156	26	63	Wind			do	
199	L. W. Jones	do	D-17		do	73	63	100	29		Gas		400.00	Domestic; irrigation.	
200	Wm. Adams	do	D-17	1897	Bored, 4-inch	76	57	101	31	64	Wind			do	
201	M. A. Yetter	do	D-17		do	74			31	62	do			Domestic	
202	A. McAlhanny	do	D-17	1882	Bored, 7-inch	75			31	65	Hand			do	
203	R. T. Barnes	do	D-17	1904	do	85	73	114	37		Wind	105.00	40.00	do	
204	J. G. Dunn	do	E-17	1885	do	81	67	134	31	64	do			Domestic; irrigation.	

Wells in the Anaheim quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
205	T. H. Bowen	Las Bolsas	E-17	1899	Bored, 7-inch	77	61	118	28	64	Gas	$120.00	$700.00	Irrigation	†30
206	H. J. Foot	do	E-17	1882	do	77	61	133	33	65	Wind			Domestic; irrigation.	
207	H. W. Head	do	E-17	1876	do	73	59	215	32		do			Domestic	
208	H. Clinton	do	F-17		do	90	72	93	32	65	do			do	
209	Lucinda Reed	do	E-17	1892	Bored, 4-inch	85	71	142	31	63	do	125.00	45.00	do	
210	D. W. McDonald	do	F-16	1904	Bored, 10-inch	108	88	80	36	63	Gas	*700.00		Irrigation	†35
211	A. B. Everts	do	F-17	1882	Bored, 7-inch	108	88	115	35	63	Wind			Domestic	
212	R. L. Greenleaf	do	F-17	1903	do	117	97	110	31	64	Hand			do	
213	D. E. Cozad	do	F-17	1897	Bored, 4-inch	119	99	77	37	63	do			do	
214	J. R. Hill	do	F-17	1902	Bored, 7-inch	122	99	92	35	64	Gas			Irrigation	†30
215	J. J. Swartzbuch	do	F-17	1892	do	124	97	98	29		Wind	100.00		Domestic	
216	Hending & Nichols	do	F-15	1902	Bored, 10-inch	120	80	120			Gas	*1,000.00		Irrigation	†40
217	J. O. Nichols	do	F-15	1903	Bored, 4-inch	118	80	131	32		Wind			Domestic	
218	do	do	F-15	1899	Bored, 7-inch	118	80	109			do			Irrigation	
219	N. Jacobson	Santa Ana	G-15		do	125		62	36	64	Hand			Domestic	
220	C. O. Ford	San Juan Cajon	G-14, 15	1897	Bored, 7-inch (2); bored, 9¼-inch.	140	89	70	34		Gas	200.00	1,260.00	Irrigation	†77
221	do	do	G-14, 15	1908	Bored, 9¼-inch	140	89	92	34						
222	do	do	G-15	1895	Bored, 4-inch	140	89	72	36	62	Wind			Domestic	
223	J. T. Megeath	Las Bolsas	F-16	1898	Bored, 7-inch	110	86	100	34		do	100.00	†100.00	Domestic; irrigation.	
224	Peter Brady	do	F-16		Driven, 1¼ inch	108	92	16	61	65	Hand			Domestic	

225	do	do	F-16		Driven, 2-inch	109	89	27	49		Wind			Stock		
226	P. D. Brady	do	F-16	1903	Bored, 6-inch	105	45	150	31		do			Domestic		
227	D. Chapin	do	E-16	1891	Bored, 4-inch	102	76	198	32		do			Domestic; irrigation.		
228	S. Bohn	do	E-16	1901	Bored, 10-inch	110	85	149	34		Gas	200.00	975.00	Irrigation	†60	
228a	do	do	E-16	1901	do	110	85	144	34		do	200.00				
229	do	do	E-16	1892	Bored, 4-inch	110	85	137	23	63	Hand			Not used		
230	F. B. Mills	do	E-16	1904	Bored, 9¼-inch	105	83	142			Gas	200.00	1,000.00	Irrigation	†70	
231	do	do	E-16		Bored, 4-inch	105	83	105	27	65	Wind			Domestic		
232	W. M. Mills	do	E-16	1904	Bored, 9¼-inch	104	83	144			Gas	250.00	1,000.00	Irrigation	†50	
233	do	do	E-16	1878	Bored, 7-inch	104	83	150	27	65	Wind			Domestic		
234	R. W. Elliott	do	E-16	1903	do	87	71	120	32	62	Hand			do		
235	W. M. Elliott	do	E-16	1903	do	88	71	200			Gas	250.00	850.00	Irrigation	†40	
236	do	do	E-16	1890	Bored, 4-inch	88	71	108	31	63	Hand			Domestic		
237	D. Conthard	do	E-16	1896	Bored, 3-inch	98	76	105	30		Wind			do		
238	do	do	E-16	1882	Bored, 7-inch	103	77	117			do			Irrigation; stock.		
239	do	do	E-16	1901	Bored, 4-inch	91	75	125	32		do			Domestic; irrigation.		
240	J. B. Eells	do	E-16	1903	Bored, 10-inch	94	76	123			Gas	150.00	1,000.00	Irrigation	†50	
241	do	do	E-16	1882	Bored, 7-inch	94	76	98	26	62	Hand			Domestic		
242	J. N. Bill	do	E-16		do	95	76	200	25		1-horse			Domestic; irrigation.		
243	Chas. Swall	do	D-16	1900	Hydraulic, 2-inch	99	76	105	29	62	Wind		145.00	Domestic		
244	A. Klein	do	D-16		Bored, 7-inch	95	74	126	28	63	Hand			do		
245	Mrs. Dr. Head	do	D-16		do	94	74	68	27	65	do			do		
246	Harry Lee	do	D-16	1903	Bored, 10-inch	90	74	152			Gas		925.00	Irrigation	†40	
247	do	do	D-16		Bored, 7-inch	90	74	110	28	63	Wind			Domestic		
248	Chester Lee	do	D-16		Driven, 1¼-inch	90	74				Hand			do		
249	A. E. Cox	Santa Ana	I-17	1894	Bored, 7-inch	185	105	110	40	62	do	150.00		do		
250	Thos. Jessup	Las Bolsas	D-16	1894	Bored, 4-inch	85	65	100	28		Wind			do		
251	D. Truesdell	do	D-16	1903	Bored, 7-inch	86	73	104	32		Gas	125.00	500.00	Irrigation	33	
252	F. D. Reed	do	D-16, 17	1882	do	85	72	153			do		700.00	do	†40	
253	J. R. White	do	D-16, 17	1888	do	84	72	118	29		Wind			Domestic		
254	do	do	D-16, 17	1898	do	84	73	145			Gas	145.00	525.00	Irrigation		

Wells in the Anaheim quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
309	J. Beckwith	Las Bolsas	B-17	1884	Bored, 7-inch	54	51	144	28	64	Hand			Domestic	
310	J. Y. Anderson	do	A-17	1875	do	50	50	80	31	64	Artesian			Stock	
311	do	do	A-17	1879	do	48	48	120	31	64	Hand			Domestic	
312	do	do	A-17		do	48	48	147	31	64	do			do	4
313	Mrs. N. T. Lyman	do	A-16	1882	do	50	50	150	31	64	do			Irrigation	12
314	S. M. Alexander	do	A-16		do	48	48	190	30	64	do			Domestic	9
315	do	do	A-16		Bored, 8-inch	49	49		31	64	do			Irrigation	3
316	B. Phelps	do	A-16, 17		Bored, 7-inch	47	47	195	25	64	do			Domestic	
317	J. H. Cole	do	A-17		Bored, 4-inch	47	47	198	28	64	do			do	
318	W. O. Huston	do	A-17		Bored, 7-inch	47	47		23	61	do			do	
319	T. H. Thompson	do	E-16	1890	do	100	83	102	28	63	Gas	$105.00	$217.00	Domestic; irrigation.	
320	H. H. Vogt	do	A-17	1897	Hydraulic, 2-inch	47	47	127	31	64	Artesian	42.00		Domestic	1
321	do	do	A-17		Bored, 7-inch	49	49	157	31	64	do	138.00		Stock	4
322	do	do	A-17	1882	do	48	48	80			do			do	
323	do	do	A-17		do	49	49	80			do			do	
324	Jacob Walton	do	A-16	1882	do	49	49	240	29	64	Hand			Domestic	
325	H. H. Vogt	do	A-17		Hydraulic, 2-inch	46	46		33	64	Artesian			Irrigation	4
326	do	do	A-17		Bored, 7-inch	46	46		28	64	do			Stock	
327	do	do	A-17		Bored, 8-inch	46	46				do			Irrigation	12
328	W. H. Johnson	do	D-16	1892	Bored, 7-inch	92	76	162	31	64	Gas		900.00	do	†60
329	G. H. Lee	do	A-16	1882	Bored, 4-inch	49	49	96	23	66	Hand			Domestic	
330	do	do	A-16		Hydraulic, 2-inch	49	49	96	27	67	do			Stock	1

331	P. A. Raab	do	A-17	1890	Bored, 7-inch	49	49	166	23	66	Steam, artesian.	200.00		Domestic	1
332	J. McCoy	do	A-17		do	44	44	205	31	65	Artesian			Domestic; stock	6
333	do	do	A-17		Hydraulic, 3-inch	40	40	100			do			Irrigation	
334	do	do	A-17		do	40	40	100	28	64	do			do	2
335	do	do	A-17	1879	Bored, 7-inch	45	45	236	28	64	do			do	
336	Westminster district school.	do	A-17		do	40	40		28	64	do			Domestic	
337	E. C. Phelps	do	A-17	1874	do	48	48	124			do			do	
338	J. N. Smith	Santa Ana	I-17	1892	do	145	94	63	38	61	Wind			do	
339	J. B. Gowdy	do	I-17	1900	do	142	92	135	38	63	do			Domestic; irrigation.	
340	McHenry Morrison	do	I-17	1901	do	155	94	101	38	60	do			Domestic	
341	J. A. Dowell	do	I-17	1901	Bored, 6-inch	150	94	127	38	60	do	172.50	+325.00	do	
342	A. S. Davis	do	J-17	1900	Bored, 7-inch	152	93	71	30	64	do	80.00	+100.00	Domestic; irrigation.	
343	A. F. Bennett	do	J-17	1901	do	148	106	100	39	62	do			Domestic	
344	F. Wakeham	do	J-17	1887	do	156	94	150	34	62	Gas, wind	*325.00		do	
345	E. R. Green	do	J-17	1900	do	146		90	40	60	Wind			do	
346	M. R. Blackmore	do	J-17		do	155	95	65	35	66	do			do	
347	T. H. Smith	do	J-17		Dug, 3 by 3 foot	147	96	54	47	64	Wind, gas			Domestic; stock	
348	C. W. Burns	do	J-17		Bored, 7-inch	145			41		Wind			Domestic	
349	W. B. Wall	do	J-17	1884	do	148		99	43	54	Gas			do	
350	H. L. Van Hise	do	K-17	1882	do	155		90	38	55	Wind			do	
351	C. E. Torrey	do	K-17	1901	do	160	90	88	37	52	do			do	
352	L. F. Thurston	do	K-17		do	152		90	37	56	do			do	
353	C. L. Cherel	do	K-17	1899	do	149		74	37	62	Hand			do	
354	H. H. Sparfield	do	K-17		do	149	70	99	42	61	do			do	
355	W. H. Kenyon	do	K-17		do	149		96	43	60	Wind			do	
356	Emily R. Smith	do	K-17	1892	do	149	100	65	37		do			Domestic; irrigation.	
357	A. G. Finley	do	L-17	1900	Dug, 3 by 3 foot	248	148	100						Not used	
358	J. D. Upton	do	K-16		Bored, 7-inch	195			42		Wind			Domestic	
359	Geo. Nay	do	K-17		do	170	93	77						Not used	
360	D. C. Drake	do	K-17	1894	Bored, 6-inch	195		75	40		Wind			Domestic	
361	W. D. Coberly	do	J-17	1882	Bored, 7-inch	165	92	85	41		do			do	
362	J. E. Luther	do	J-17	1899	do	168	92	112	45	65	do	105.00		do	

Wells in the Anaheim quadrangle—Continued.

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						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
363	A. E. Bradley	Santa Ana	J-17		Bored, 7-inch	178	95	94	47		Wind			Domestic	
364	E. J. Stellberg	do	J-15	1899	do	180		114	45	65	do			do	
365	Joe Fitchen	do	J-16	1892	do	220	117	127	38		do	$200.00		do	
366	Claus Seba	do	J-16		do	212	107	108	41		do			do	
367	R. Frick	do	J-16	1898	do	210	99	125	41		do			do	
368	C. B. Campbell	do	I-16		do	110			41		do			do	
369	J. A. Meeg	do	I-16	1899	do	205	116	134	38		do	200.00	$100.00	do	
370	A. D. Bishop	do	I-16	1880	do	205	121	109	50		Gas			do	
371	Joseph Young	do	I-16	1874	do	201	111	100	63		Wind, gas			do	
372	Mrs. H. Laeter	Las Bolsas	A-17		do	48	48	129	30	64	Artesian			Stock; irrigation.	†4
373	do	do	A-17		Hydraulic, 3-inch	47	47	120	31	64	do			Domestic	
374	do	do	A-17	1874	Bored, 7-inch	47	47	122	31	64	Wind, artesian			do	
375	do	do	A-17		Driven, 4 by 6 inch.	48	48	65	26	64	Artesian				
376	H. Laeter	do	B-17		Bored, 4-inch	48	48	130	27	64	do			Domestic	
377	do	do	B-17	1879	Bored, 7-inch	46	46	64	28	64	Gas, artesian		675.00	Irrigation	†10
378	Orange County	do	A-17	1901	Hydraulic, 3-inch	47	47	120			Artesian			Roads	
379	do	do	A-17	1901	do	48	48				do			do	
380	Mrs. B. A. Hazard	do	A-17	1878	Bored, 7-inch	46	46	135		64	do			Domestic; irrigation.	9
381	A. D. Bishop	do	A-17		Bored, 4-inch	46	46		27	64	do			Domestic	2
382	do	do	A-17		Bored, 7-inch	45	45	139	29	63	do			Irrigation	24
383	S. J. Murdock	do	A-17	1890	do	46	46		27	63	do			do	

384	Wm. Hoskings	do	A-17		Hydraulic, 2-inch	47	47	120	31	63	do			do	3
385	I. Chapman	do	A-17		Bored, 7-inch	47	47	82	32	65	do			do	
386	do	do	A-17		Hydraulic, 3-inch	47	47		35	64	do			Domestic	
387	do	do	A-17		Hydraulic, 2-inch	47	47		35	66	do			Irrigation	
388	Mrs. Riddlebach	do	A-17		Bored, 4-inch	47	47	108	33	64	do			Domestic	2
389	U. S. Lemon	do	A-17		do	46	46		31	64	do			do	
391	W. J. Edwards	do	A-17		do	46	46		27	59	do			do	
392	C. L. Williams	do	A-17		do	46	46		32	65	do			do	2
393	D. W. Osburn	do	A-17	1882	do	45	45	110	31	65	do			Domestic; irrigation.	14
394	J. J. Pyle	do	A-17	1874	Bored, 7-inch	45	45	80	33	65	Hand, artesian.			Domestic	
395	do	do	A-17	1899	Hydraulic, 2-inch	45	45	107	35	64	Artesian	36.00		Irrigation	1
396	F. Wright	do	A-17	1900	Bored, 7-inch	44	44	100	32	65	do			Domestic; irrigation.	4
398	I. Chapman	do	A-17		do	45	45	96	33	65	do			Irrigation	8
400	Mrs. L. J. Hosking	do	A-17		Bored, 4-inch	48	48	55	29	65	do			do	5
401	do	do	A-17		Hydraulic, 2-inch	48	48	94	33	64	do			do	3
402	J. C. Joplin	do	A-16		Bored, 6-inch	49	49	84	31	64	do			Domestic	
403	do	do	A-16		Bored, 7-inch	49	49	190	29	64	do			Irrigation	1
404	do	do	A-16		do	49	49	200+	28	64	do			do	1
405	L. Wade	Santa Ana	H-16	1884	do	176		160	37		Wind			Domestic	
406	Mrs. Thompson	do	H-16	1900	Bored, 10-inch	192	25	167			Not raised	400.00		Not used	
407	F. M. Stocking	do	H-15		Bored, 7-inch	195		99	36		Wind			Domestic	
408	C. H. Morse	do	H-16	1890	do	175	117	140	32	65	do			do	
409	Wm. Pilcher	do	H-16	1897	Hydraulic, 2-inch	170		178			Not raised			Not used	
410	J. M. Morrison	do	H-16	1884	Bored, 7-inch	182	134	114	44		Hand			Domestic	
411	C. Oehlke	do	I-16		Bored, 8-inch	201		175	30		Gas			do	†7
412	H. W. Schoepf	do	I-16	1884	Bored, 6-inch	192	112	115	31		Wind			do	
413	A. L. Havens	do	I-16	1894	Bored, 7-inch, 66 feet; 6-inch, 66 to 120 feet.	182		126	37	64	do			do	
414	A. Schildmeyer	do	I-16	1894	Hydraulic, 2-inch	200	124	183	38		do	+ 200.00		do	
415	D. F. Campbell	do	I-16	1894	Bored, 7-inch	210		106	38		do			do	
416	A. H. Bibber	do	I-15	1884	do	225	146	122	39		do			do	
417	Geo. Acheson	do	I-15		do	210			38		do			do	
418	E. Arrowsmith	Los Alamitos	A-16		do	48	48	240	29	65	Artesian			Irrigation; stock.	

Wells in the Anaheim quadrangle—Continued.

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						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
419	W. Junkins	Los Alamitos	A-16		Bored, 7-inch	48	48	200+	29	64	Artesian			Domestic	1
420	do	do	A-16		Hydraulic, 3-inch	48	48	200+	28	64	do			Irrigation	3
421	A. M. Ladd	do	A-15	1896	Hydraulic, 2-inch	52	52	248	30	65	Hand, artesian			Domestic	
422	do	do	A-15	1900	Hydraulic, 3-inch	50	50	236	28	65	Artesian			Irrigation	4
423	Geo. E. Dundas	do	A-16	1894	Bored, 7-inch	53	53	196	30	65	do			do	9
424	M. S. Currier	do	A-16	1898	Hydraulic, 2-inch	52	52	180	27	65	do			Domestic	1
425	do	do	A-16		Bored, 6-inch	52	50	180			Not raised			Not used	
426	T. F. Derrick	do	A-16	1901	Driven, 2-inch	53	41	14	40	63	Hand			Domestic	
427	do	do	A-16	1901	Dug, 2 by 3 foot	52	46	8	93	61	do			Stock	
428	do	do	A-16	1894	Bored, 2-inch	52	52	240			Not raised			Not used	
429	Mr. Cutler	do	A-16		Hydraulic, 2-inch	51	50		27	65	Hand			Stock	
430	Geo. Hodgkinson	do	A-15	1889	Bored, 7-inch	54	52	198	25		Wind			Domestic	
431	J. R. Swayze	do	A-16	1877	do	55	52	277	29		do			Domestic; irrigation.	
432	do	do	A-16	1887	do	55	52	98	28	65	Not raised	$115.00		Not used	
433	do	do	A-16	1895	do	54	52	274	28	65	do	500.00		do	
434	do	do	A-16	1895	Bored, 4-inch	52	52	93	26	65	Artesian			Irrigation	
435	Adolf Ekstein	do	A-15	1880	Bored, 7-inch	56	54	260	25	64	Hand			Domestic	
436	do	do	B-15	1884	do	60	58	260			Gas		$600.00	Irrigation	†25
437	do	do	A-15	1897	Hydraulic, 2-inch	54	50	315			Not raised			Not used	
438	do	do	A-15	1894	Bored, 7-inch	56	54	265	32		Wind			Stock; irrigation	
439	do	do	A-15	1897	Hydraulic, 2-inch	56		265			do	100.00		Domestic	
440	S. Hill	do	A-15	1892	Bored, 7-inch	55	52	260	30	64	do	360.00	+250.00	do	

441	Oliver Hill	do	B-15	1892	do	56	53	200	30	64	Hand	*252.00		Stock	
442	do	do	A-15	1890	Dug, 4 by 4 foot	58		10	51	62	do			do	
443	Mrs. A. Becket	do	B-15	1878	Bored, 7-inch	62	55	184	34		Wind			Domestic	
444	Alfred Beckett	do	B-15	1884	do	64	54	230	29		do			Domestic; irrigation.	
445	S. F. Everett	do	B-16	1876	do	64		145	31	64	do			Domestic	
446	do	do	B-15	1895	Hydraulic, 3-inch	64			38		do			Stock	
447	J. C. McLain	do	B-15	1880	Bored, 7-inch	62	54	151	30	62	Hand			Domestic	
448	Mrs. L. H. Armstrong	do	B-15	1880	do	62	54	158	31	64	do			do	
449	D. L. Leverdeau	do	B-15		Bored, 4-inch	61	54	158	30		Wind			Domestic; irrigation.	
450	R. Herren	do	B-15	1884	Bored, 7-inch	61	56	145	31	64	do			Domestic	
451	do	do	B-15	1884	do	61	56	145			Not raised			Not used	
452	T. Y. Long	do	B-15	1884	do	68	56	170	31		Gas		500.00	Domestic; irrigation.	†45
453	Frank M. Rogers	do	B-15		Bored, 4-inch	73	60	180	31		Wind			do	
454	R. C. Young	do	B-16		Bored, 7-inch	74			31		do			do	
455	H. C. Parmley	do	B-16	1903	do	70	62	165	29	65	Gas	*1,200.00		Irrigation	†90
456	do	do	B-16	1903	do	70	62	165	29	65	do			do	
457	H. A. Young	do	B-15	1904	do	68	58	176	29	66	Hand	175.00		Not used	
458	do	do	B-15	1890	Driven, 1¼-inch	61		14	51	65	do			Domestic	
459	do	do	B-15		Bored, 7-inch	69	59	175			Not raised				
460	D. McMillian	do	B-16	1889	do	70	62	158	29	65	Hand			Domestic	
461	D. Nichols	do	B-16	1884	do	71	62	160	31	65	Wind			Domestic; irrigation.	
462	do	do	B-16	1889	Hydraulic, 2-inch	70	62	160			Not raised				
463	D. K. Sanford	do	B-16	1892	Bored, 7-inch	71	62	156	31	64	Wind			Domestic; irrigation.	
464	O. B. Baxter	do	C-16	1889	Bored, 6-inch	73	62	148	29		Horsepower			do	
465	David Burkhart	do	C-16	1880	Bored, 7-inch	76	66	148	31	65	Hand			Domestic	
466	F. G. Steward	Las Bolsas	C-16	1884	do	85	69	200	31	65	Wind			do	
467	E. A. Chaffee	do	C-16	1878	do	85	75	146	33		do			do	
468	J. Dement	do	G-16	1887	do	82	76	126	31	65	Horsepower			Domestic; irrigation.	
469	D. W. Lawton	do	C-16	1880	do	76	60	158	28		Wind			do	
470	W. McCullough	do	C-16	1874	do	87			29		do			do	
471	J. W. Hill	do	C-16	1884	do	85	78	124	31	64	do			Domestic	

Wells in the Anaheim quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
472	J. D. Chaffee	Las Bolsas	C-16		Bored, 7-inch	85			31	64	Wind			Domestic	
473	A. J. Chaffee	do	C-16	1880	Bored, 4-inch	85	70	118	30	64	do			do	
474	Mrs. Esterbrook	do	C, D-16	1882	Bored, 7-inch	87	71	132	27	64	Wind, hand			do	
475	James Sturgess	do	D-16	1880	do	84	71	112	31	64	Hand			do	
476	W. W. Sterns	do	C-15	1890	do	83	71		27		Wind			do	
477	G. W. Ramsey	do	C-15	1890	Bored, 6-inch	83		148	29	65	Hand			do	
478	Harvey Miller	do	C-16	1895	Bored, 4-inch	83	71	160	31		Gas	*$800.00		Domestic; irrigation.	†40
479	Thos. Lyons	Los Alamitos	C-16		Bored, 7-inch	82	70	160	31	64	Hand			Not used	
480	W. Chaffee	do	B, C-15	1897	do	82	70	150			do			do	
481	R. H. Pulley	do	B-16	1882	do	76	64	146	31	65	Gas		$500.00	Irrigation	†60
482	Mr. Herman	do	B, C-15		do	78	66	161	31	65	Hand			Domestic	
483	L. A. Preston	Los Coyotes	C-15	1902	Hydraulic, 2-inch	88	68	92			Gas	40.00	150.00	Irrigation	
484	do	do	C-15	1895	do	88	68	150	27		Wind	60.00	40.00	Domestic	
485	do	do	C-15	1890	Bored, 7-inch	88	68	98	29	65	Hand			do	
486	E. A. Preston	do	C-15	1902	Hydraulic, 2-inch	86	68	92	29	65	Wind	40.00		Domestic; irrigation.	
487	do	do	C-15	1903	Bored, 7-inch	100	73	165			Gas	163.00	600.00	Irrigation	
488	do	do	C-15	1903	do	100	73	144			do			do	
489	Frank Wayman	do	C-15	1890	do	89	69	146	31	65	do	*1,250.00		do	†30
490	O. E. Heathe	do	C-15	1880	Bored, 6-inch	89	68	105	29	64	Wind			Domestic	
491	Garden Grove	do	C-15	1876	Bored (2), 7-inch	88	73	140			Gas	140.00	1,800.00	Irrigation	†100
492	Irrigation Co														

493	J. W. Hawkins	do	C-15		Hydraulic, 2-inch	88	73	100	29	65	Hand			Domestic	
494	E. J. Ware	do	D-15	1877	Bored, 7-inch	100	74	185	35		Gas	400.00	830.00	Irrigation	†40
495	F. M. Adams	do	D-15		Bored, 6-inch	94			32	65	Wind			Domestic	
496	Mrs. H. A. Warner	do	D-16	1877	Bored, 7-inch	87		212	35		Gas		700.00	Irrigation	†45
497	J. M. Woodruff	do	D-16	1890	do	85	73	189	31	65	Hand			Domestic	
498	Henry Assop	do	D-16	1903	Bored, 11-inch	90	74	98	28		Gas		165.00	Irrigation	†20
499	do	do	D-16	1896	Bored, 2-inch	90	76	100			Flows into pit	25.00		do	
500	E. Cochran	do	D-15	1894	Bored, 7-inch	95	75	140	30	65	Gas		385.00	Irrigation; domestic.	†20
501	O. A. Moody	do	D-14	1902	Hydraulic, 2-inch	95	77	106	30		Wind			Domestic; irrigation.	
502	do	do	D-16	1902	do	95	97	104	26		do			Domestic	
503	A. J. Newsome	do	D-16	1894	Bored, 7-inch	101	80	116	31	64	Gas, wind			Irrigation; domestic.	†10
504	do	do	D, E-16	1882	do	98	80	109			Not raised				
505	G. S. Martin	do	E-16	1894	do	105	87	104	31	64	Hand			Domestic	
506	W. M. Mills	do	E-16	1892	Bored, 4 inch	107	90	102	31		Wind			do	
507	Mrs. S. M. Mills	do	E-16	1872	Bored, 7-inch	104	88	133	31		do			Domestic; irrigation.	
508	S. Penfold	do	E-15	1904	Bored, 10-inch	110	90	120	34	65	Hand			Domestic	
509	J. L. Roach	Las Bolsas	E-16		Hydraulic, 2-inch	114	84	80	30		Wind			do	
510	B. Y. Duke	do	E-16	1891	Bored, 7-inch	114			32		do			do	
511	John McMillian	do	E-15	1902	Bored, 4-inch	112	92	94	31		do			do	
512	Hugh Rule	do	E-15	1892	Bored, 7-inch	119	88	107	35		do			do	
513	R. L. King	do	E-15	1903	Hydraulic, 4-inch	118	88	98	30	65	do	65.00	30.00	Domestic; irrigation.	
514	A. Carmicael	do	E-15	1898	Bored, 7-inch	120		116	31		do	100.00	+210.00	do	
515	I. B. Luther	do	E-15	1904	Bored, 4-inch	120		109	33	65	Hand			Domestic	
516	do	do	E-15	1902	Bored, 10-inch	124	87	134			Gas	125.00	1,950.00	Irrigation	†90
517	do	do	E-15	1901	Hydraulic, 2-inch	124	87	104	35	65	Hand	40.00		Domestic	
518	W. E. Schnitger	do	D-15	1899	Bored, 7-inch	102	77	106	33		Wind, gas			do	
519	do	do	D-15	1900	Bored, 9¼-inch	105	78	143	31	62	Gas		1,500.00	Irrigation	126
520	do	do	D-15	1901	Bored, 7-inch	105	78	155			do			do	
521	A. A. Schnitger	do	D-15	1884	do	102	77	130	35	64	Hand			Domestic	
522	C. Holt	do	D-15	1897	Hydraulic, 2-inch	106	79	98	35		Wind			do	
523	J. Parks	do	E-15	1901	Bored, 7-inch	110	81	125	31		do			do	
524	R. J. Thompson	do	E-15	1903	do	115	80	114	33	62	Hand	104.00		do	

Wells in the Anaheim quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
525	E. J. Minyard	Las Bolsas	E-15	1900	Hydraulic, 2-inch	110	78	87	23	65	Wind	$50.00	+$135.00	Domestic	
526	C. E. Lighthall	do	E-15		Bored, 4-inch	111	78	110	38		do			do	
527	F. A. Nelson	do	E-15	1898	Bored, 7-inch	117		168	29		do	160.00	60.00	Domestic; irrigation.	
528	C. Christensen	do	D-15		do	106	76	140	31		Gas		220.00	Domestic	
529	do	do	D-15	1900	do	108	78	154			do	155.00	1,250.00	Irrigation	†90
530	do	do	D-15	1900	do	108	78	132			do			do	
531	E. P. Fowler	do	D-14	1895	do	114	78	150			do			do	123
532	do	do	D-14	1896	do	114	78	271			do			do	
533	do	do	D-14	1897	Bored, 10-inch	114	78	150			do			do	
534	do	Los Coyotes	C-14	1899	Bored, 7-inch	103	76	160			do			do	96
535	do	do	C-14	1899	do	103	76	150			do			do	
536	do	do	C-14	1900	Bored, 8-inch	103	76	179	36		Gas, wind			Irrigation; domestic.	
537	do	do	C-14	1901	Bored, 7-inch	103	76	138	37		Wind			Domestic	
538	W. A. Newbery	Las Bolsas	D-14	1897	Bored, 10-inch	105	78	187			Gas		1,000.00	Irrigation	†108
539	do	do	D-14	1897	Bored, 7-inch	105	78	187	31	65	do			do	
540	do	do	D-14	1902	do	105	78	188			do			do	
541	Albert Bruskey	do	D-14, 15	1901	do	107	78	141	31	65	do	175.00	825.00	do	†85
542	P. B. Roy	do	E-15	1903	do	117	83	120			do		2,200.00	do	†135
543	do	do	E-15	1903	do	117	83	140			do			do	
544	do	do	E-15	1903	Bored, 6-inch	117	83	160	31		do			Domestic; stock	
545	W. W. Mewter	do	E-14	1901	Bored, 10-inch	120	81	131	29		do	165.80	1,588.00	Irrigation	98

546	J. A. Knapp	do	E-14	1900	Bored, 7-inch	120	81	137	31		do	135.00	900.00	do	†45
547	J. F. Culton	Los Coyotes	C-14	1890	do	98	75	247	42		Wind			Domestic	
548	J. W. Heart	Las Bolsas	D-14	1901	do	118	78	120	30		Gas	186.00	850.00	Irrigation	†40
549	W. J. Freeman	do	E-14	1903	Bored, 10-inch	120	80				do	*2,500.00		do	†110
550	do	do	E-14	1903	Bored, 12-inch	120	80				do			do	
551	do	do	E-14, 15		Bored, 7-inch	119			35		do		150.00	Domestic	
552	L. H. Wilcox	San Juan Cajon	E-13	1903	Hydraulic, 3-inch	135		98	27		Wind			do	
553	Hugh Grice	do	D-14	1901	Bored, 7-inch	112	82	138	31		do			do	
554	J. B. Neff	do	E-14	1894	do	135	88	100			Steam	90.00	2,800.00	Irrigation	†150
555	do	do	E-14	1898	do	135	88	100			do	105.00		do	
556	do	do	E-14	1897	do	134	89	113	32	65	Wind	100.00		Domestic	
557	W. L. Knowlton	do	E-13	1901	do	135	89	105			Gas	*1,200.00		Irrigation	†40
558	do	do	E-13	1903	Bored, 4-inch	133		96	33	65	Hand	32.00		Domestic	
559	Elizabeth Enearl	Las Bolsas	D-14	1894	Bored, 7-inch	120	82	110	36		Wind	94.00		do	
560			D-14	1902	do	120	82	149			Gas	114.00	1,500.00	Irrigation	†75
561	F. Newhall & Son	do	C-14		do	105	78				Wind			Domestic	
562	A. E. Nutt	Los Coyotes	C-14	1901	do	105	78	165			Gas	*2,000.00		Irrigation	†80
563	do	do	C-14	1901	do	105	78	169			do				
564	W. E. Case	Las Bolsas	D-15	1897	do	104	78	148	32	64	Hand			Domestic	
565	Gray Bros	do	D-15	1897	Hydraulic, 2-inch	104	78	136	31	64	Wind			Irrigation	
566	do	do	D-15	1900	Bored, 7-inch	104	78	247			do			do	
567	J. W. Cornelison	Santa Ana	H-15	1899	Dug, 3-foot diameter.	202	124	85	42		do			Domestic	
568	H. Bergemann	do	I-15, 16	1900	Bored, 7-inch	208	105	115			do			do	
569	H. Nieffer	do	I-15, 16		do	208			42		do			do	
570	Mrs. M. L. Travis	do	I, J-15	1896	do	228		120	41		do	125.00	+250.00	do	
571	J. C. Hyle	do	I-15	1897	do	228		119	33		do			do	
572	Geo. Schmidchen	do	J-15	1901	do	228		131	47		do	135.00		do	
573	Chas. Harter	do	J-16	1897	do	223		138	42		do	200.00		do	
574	W. F. Kaiser	do	J-15	1901	do	235	101	138	44		do			do	
575	D. C. Drake	do	I-15		do	226	111	118	42		do			do	
576	A. H. McCollum	do	I-15	1897	do	225		119	39		do			Domestic; irrigation.	
577	A. F. Schubert	do	I-15	1897	do	224		125	34		do	*300.00		Domestic	

Wells in the Anaheim quadrangle—Continued.

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						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
578	Orange City Water Company.	Santa Ana	I-15		Bored, 9-inch	206	104	120			Gas			Not used	
579			I-15	1902	Bored, 12-inch, 440 feet. Bored, 10-inch, 180 feet.	230	121	620			Steam			Domestic	2
580	H. Fitchen	do	J-15	1900	Bored, 7-inch	248	125	148	44		Wind			do	
581	Henry West	do	J-15	1880	Dug, 2½-foot diameter.	250	125	128			do			do	
582	H. S. Grenenwald	do	L-15	1900	Bored, 7-inch	320	276	85	42		Gas			Domestic; irrigation.	† 12
583	Perkins Bros	do	K-14	1900	do	276	91	247	56		do	$302.80	$1,150.00	do	† 17
584	R. Emmick	do	H-15	1884	do	165	103	80	52	65	Hand			Domestic	
585	Mrs. C. R. Bush	do	H-15	1896	do	165	100	66	53		Wind			do	
586	Iven Ruck	do	H-15	1899	do	165		118	27		Hand			do	
587	W. A. Morrison	do	H-15	1894	do	165		128	83		do			do	
588	Mrs. Thos. Goss	do	H-14	1901	do	165	105	142	85		Gas			Domestic; irrigation.	
589	T. P. March	do	H-14		do	170			48		Wind			do	
590	H. Loptien	do	H-14	1870	do	170	100	74	51	65	do			Domestic	
591	Fred W. Struck	do	H-14	1894	do	168	102	72	49	65	do			do	
592	H. Rensch	do	H-14	1882	do	166	105	66	47		do			do	
593	R. Paulus	do	H-14	1902	do	165	105	70	52	65	Hand			do	
594	Max Struck	do	H-14	1902	do	167		72	42	65	Wind			do	
595	Fred Gerken	do	H-14	1900	do	165		72	45		do			do	

596	T. H. Brown	do	H-14	1899	do	170		123	30	65	do			Domestic; irrigation.	
597	W. Raugh	do	I-15	1898	do	205		95	42		do			Domestic	
598	Mrs. C. P. Mallory	do	I-14	1900	do	208		140	42		do			do	
599	F. H. Hollister	do	I-14		do	193	112	87	38		do			do	
600	C. S. Spencer	do	I-14	1896	do	188		129	33		do			do	
601	Henry Bosch	do	I-14		do	193			35	65	Hand			do	
602	Henry Rodieck	do	I-14	1901	do	191			39		Wind			do	
603	S. S. Raugh	do	I-14	1902	do	180		142	37		do			do	
604	O. Dowens	do	I-14		do	185	85	128	31		do			do	
605	A. C. Elliott	do	I-14	1890	do	195	95	142	29		Gas			Domestic; irrigation.	
606	C. F. Johnson	do	I-14	1903	do	200	92	128	38		Wind	200.00	+400.00	Domestic	
607	Chas. Carlson	do	I-14	?1882	Bored, 6-inch	207	100	100	40		do			do	
608	S. M. Davis	do	I-14	1901	Bored, 7-inch	213		110	39		do			do	
609	J. W. Rice	do	I-15		do	215		150	40		do			do	
610	John Hanson	do	I-15	1897	do	220		117	35		do			do	
611	J. H. Kurtz	do	I-15	1902	Dug, 3-foot diameter.	225	126	104	32		Hand			do	
612	Rob Apple	do	I-15	1900	Bored, 7-inch	224		122	37		Wind	145.00		do	
613	G. D. Toothaker	do	I-14	1900	do	218	118	130	38		do	195.00	80.00	do	
614	William Bierwagen	do	J-14	1900	do	232	100	147	37		do	150.00		do	
615	A. N. Saxton	do	J-15	1903	do	237	147	130	37	65	do			do	
616	R. S. Williams	do	J-15	1897	do	258	119	140			Not raised				
617	G. W. Brown	do	J, K-13, 14.	1899	Dug, 3 by 3 foot, 180 feet; bored, 7-inch, 12 feet.	298	98	200	43		Wind			Domestic	
618	C. O. Field	do	J-13, 14	1902	Dug, 3-foot diameter.	285	233	53	39	66	Hand			do	
619	Geo. Jesson	do	J-13		Bored, 7-inch	296	dry	161			Not raised				
620	J. P. Williams	do	K-13	1901	Dug, 3-foot diameter.	325	dry	210			Hand				
621	Villa Park school district.	do	K-14		Bored, 7-inch	300	100	225			Wind			Domestic	
622	S. A. Gilbert	San Juan Cajon	F-14	1901	do	135	95	122	35	65	do			Domestic; irrigation.	
623	A. P. Smith	do	F-14	1899	do	132	92	112	30		do			do	
624	John Wheaton	do	F-14	1897	Hydraulic, 2-inch	130	89	108			do	40.00		do	

Wells in the Anaheim quadrangle—Continued.

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						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
625	J. M. Willoughby	San Juan Cajon	F-14	1904	Driven, 2-inch	133	87	80	29	65	Gas			Domestic	
626	do	do	F-14	1904	Bored, 10-inch	133	87	125			Not raised at present.				
627	S. M. Wren	do	F-14	1900	Bored, 7-inch	135		107	33		Wind	$105.00		Domestic	
628	J. B. Bowman	do	F-14	1904	Bored, 10-inch	139	87	102	32	62	Gas	275.50	$1,000.00	Irrigation	†35
629	A. Warner	do	E-14	1901	do	125	85	127			do	*1,500.00		do	†60
630	J. B. Ray	do	E-14	1901	do	127	84	115			do	202.00	1,800.00	do	†80
631	do	do	E-14	?1882	Bored, 4-inch	127	84	90	44		Wind			Domestic	
632	G. C. Hiatt	Las Bolsas	D-14	1900	Bored, 7-inch	120	84	198			Gas	*1,800.00		Irrigation	†125
633	do	do	D-14	1900	do	120	84	150			do			do	
634	do	do	D-14	1904	do	120	84	145			do			do	
635	do	do	D-14	1898	do	115	81	108	40		Wind			Domestic	
636	O. E. Cheesebrough	Los Coyotes	C-14		do	98	76	100	52	67	do			do	
637	do	do	C-14		do	98	75	96			do			Irrigation	
638	T. J. Jones	do	C-14	1890	do	86	74	260	43	66	do			Domestic	
639	do	do	C-14	1900	do	101	82	165			Gas	*1,400.00		Irrigation	†70
640	W. J. Hill	do	C-15	1885	Bored, 8-inch	87	69	100	36		do			Domestic	
641	do	do	C-15	1875	Bored, 7-inch	87	69	170			Steam			Irrigation	†70
642	S. Christensen	Los Alamitos	C-15	1885	do	82	65	176	31	65	Wind			Domestic	
643	C. N. Brown	Los Coyotes	B-15	1880	do	79	67	181	34	66	Hand			do	
644	F. A. Gates	do	B-15	1898	Hydraulic, 2-inch	77	67	140	38	64	Wind			Domestic; irrigation.	
645	Mrs. Nellie Town	do	B-15	1877	Bored, 7-inch	77	67	180	38	65	do			do	

646	C. J. D. Beck	do	B-14	1903	Hydraulic, 2-inch	79	67	254	26	66	do			do		
647	E. L. Kellogg	do	C-14	1903	Bored, 7-inch	110	84	100	41		do			Domestic		
648	J. Detemph	Las Bolsas	D-14		do	110	82	100	35	65	do			do		
649	T. L. Garrison	San Juan Cajon	E-14	1904	do	128	86	129	25	62	Gas	*2,000.00		Irrigation	48	
650	do	do	E-14	1904	do	128	86	131	25	62	do			do		
651	A. R. Dresser	Santa Ana	H-17	1888	do	150		58	46		Wind			Domestic		
652	Otis Jones	do	H-17	1889	do	150		59	56		do			do		
653	H. M. Seyor	do	H-17	1889	do	150		56	49		do			do		
654	J. Chandlier	do	H-17	1888	do	135	90	65	49		do			Domestic; irrigation.		
655	J. H. Sharp	do	K-16	1900	Bored, 9¼-inch	200	83	136	43	66	Hand			Domestic		
656	H. M. Morse	do	H-17	1900	Bored, 7-inch	162		90	43		Wind, gas			Domestic; irrigation.		
657	J. A. Oderlin	do	I-17	1888	do	161	100	65	53		Wind			Domestic		
658	H. W. Sylvester	do	H-17		do	141	93	58			do			Domestic; irrigation.		
659	M. A. Kiefhaber	do	M-14	1892	Dug, 2 by 2 foot	475	460	21	57		do			Domestic		
660	J. N. Long	Los Coyotes	B-15	1903	Bored, 7-inch	80	65	170	45		do			do		
661	do	do	B-15	?1882	do	80	65	170			Gas			Irrigation	†90	
662	do	do	B-15	1902	do	80	65	161			do			do		
663	S. S. Ball	do	C-14		Bored, 4-inch	94			32	65	Wind			Domestic		
664	Ruben Kidner	do	C-14		Hydraulic, 2-inch	98			41	65	Hand			do		
665	S. S. Ball	do	C-13		Bored, 10-inch	105	77	145	34	65	Gas			Irrigation	†90	
666	do	do	C-13	1901	do	105	77	145	34	65	do			do		
667	W. R. Clark	do	B-13		Bored, 4-inch	88	72	100	21	66	Wind			Domestic		
668	do	do	C-13	1904	Bored, 7-inch	92	72	175			Gas			Irrigation		
669	do	do	C-13	1904	do	92	72	176			do			do		
670	P. A. Stanton	do	B-14		Bored, 3-inch	87			34	65	Hand			Stock		
671	W. A. Blizzard	do	B-13	1901	Hydraulic, 2-inch	85	70	147	35	65	Wind	100.00		Domestic		
672	J. M. Gilbert	do	B-14	1897	do	80		96	45		do			do		
673	do	do	B-14	1897	do	80		495			do			do		
674	do	do	B-13	1902	do	80		108	35	65	Hand			Stock		
675	W. J. Thompson	do	B-14	1892	Driven, 1¼-inch	74		35	32	65	do			Domestic		
676	A. Barter	do	B-14	1894	Bored, 7-inch	72	60	168	25	64	Wind			Domestic; irrigation.		
677	do	do	B-14	1898	Hydraulic, 2-inch	72	60	533	28	64	Hand			do		

Wells in the Anaheim quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
678	W. H. Kennedy	Los Coyotes	B-14	?1882	Bored, 7-inch	73	62	183	33	65	Gas	*$1,000.00		Irrigation	68
679	do	do	B-14	1904	do	73	62	183	33	65	do			do	
680	J. H. Brown	do	B-14	1897	Hydraulic, 2-inch	73	62	265			Not raised				
681	De Los Marton	do	B-14	1904	Bored, 7-inch	72	62	146	32	65	Wind	145.00		Domestic	
682	James Kearns	do	B-14	1899	Hydraulic, 2-inch	72	62	276	32	65	do			Domestic; irrigation.	
683	T. Hill	do	B-14	1892	Driven, 1¼-inch	72		42	33	65	Hand			Domestic	
684	do	do	B-14	1897	Hydraulic, 2-inch	72	62	267	32	65	Wind			Domestic; irrigation.	
685	L. Hickox	do	B-14		Driven, 1¼-inch	71		14	27	65	Hand			Domestic	
686	J. Snow	do	B-14	1894	Bored, 4-inch	70	63	224	32		Wind			Domestic; irrigation.	
687	J. J. Hayes	Los Alamitos	B-15	1897	do	69	60	200	31	65	Hand			Domestic	
688	J. Corner	do	B-15	1896	Hydraulic, 2-inch	70	64	200+	40		Wind			do	
689	J. W. McClellen	Los Coyotes	C-14	1900	Bored, 7-inch	87	67	158			Gas	*1,400.00		Irrigation	†100
690	do	do	C-14	1904	do	87	67	172			do	170.00		do	
691	do	do	C-15	1880	do	87	67	365	28		Wind			Domestic	
692	Mrs. M. Merideth	San Juan Cajon	E-13		Dug, 3 by 3 foot; bored, 7-inch.	137			30		do			do	
693	H. E. Hunt	do	D, E-14	1903	Bored, 7-inch	126		113	33	66	Hand	100.00		do	
694	Robert Hansen	do	E-13	1894	Hydraulic, 2-inch	130	90	100	45		Wind	35.00		do	
695	A. O. Luer	Las Bolsas	D-13		Bored, 7-inch	118	88	101	50		do			do	
696	E. J. Sparkes	do	D-13	1894	Bored, 4-inch	118		100	46		do			do	
697	F. D. Merton	do	D-13	1894	Bored, 7-inch	112	84	110	44		do			do	

698	R. Westfall	do	D-14		do	115	85	96	58		do			do		
699	E. A. Sparkes	do	D-13	1894	do	115	84	100	68		do			do		
700	Mrs. M. Lare	Los Coyotes	B-14	1892	Bored, 4-inch	70			29	65	Hand			do		
701	A. Franklin	do	A-14	1903	Hydraulic, 3-inch	66	63	138	31	65	do			do		
702	J. E. Miller	do	A-14	1896	Hydraulic, 2-inch	66			31		Wind			do		
703	J. Everharte	do	A-14	1902	Bored, 7-inch	62	57	144	32		Hand			do		
704	J. R. Newsom	do	A-14	1897	Hydraulic, 2-inch	55	52		31	65	Wind			do		
705	J. Stearn	do	A-14		do	53			31	65	Hand			do		
706	R. Kruger	do	A-14		do	54					Wind			Stock		
707	Ludwig Kunkel	do	A-13	1903	Driven, 1¼-inch	62	54	11	84	64	Hand			Domestic		
708	C. W. Overton	San Juan Cajon	E-11		Bored, 7-inch	152	122	70	35		Wind			do		
709	G. A. Mills	do	E-10	1897	Hydraulic, 2-inch	150	122	136	30		do	40.00		do		
710	A. G. Miller	do	E-10		Bored, 4-inch	148		60 +	30		do			do		
711	Ed Basley	do	E-10	1903	do	147		135	33		do			do		
712	R. S. Gregory	do	E-10	1899	do	150			40		do			Domestic; irrigation.		
713	J. Naeger	do	E-9	1890	do	165	125	120	77		do			Domestic		
714	Orange City Water Co.	do	E-9	1886	Bored, 11¼-inch	165	98	118	75		Steam			do		92
715		do	E-9	1886	Bored, 7-inch	165	98	196			Gas			Not used		
716	H. S. Russel	do	E-10	1901	do	152	124	175	75		Wind			Domestic		
717	A. Hiltscher	do	E, D-9	1898	Bored, 4-inch	150	95	154	41		Gas			Domestic; irrigation.		
718	Orange Co. Nursery	do	D-9	1899	Bored, 7-inch	148	103	191	69		Electricity			do		†12
719	A. McDermont	do	D-9	1889	do	149	99	100	39		Wind			do		
720	Geo. Fiscus	do	F-13	1890	do	144	91	95	37		do			Domestic		
721	Wm. Kalbary	Santa Ana	H-14	1901	Dug, 4-foot diameter, 64 feet; bored, 6-inch, 24 feet.	165	103	88	43		do	100.00	$45.00	do		
722	Sam. Keuchel	do	H-13	1900	Bored, 7-inch	178	113	95	43		do			do		
723	F. W. Hughes	do	H-13	1900	Dug, 30-inch diameter.	185	115	73	48		do			do		
724	Ray Krueger	do	H-13	1903	Dug, 3½-foot diameter.	187	115	75	36		Hand			do		
725	Wm. Nolbe	do	H-13	1904	do	188	118	72	38		do			do		
726	J. P. Coyne	do	I-13		Bored, 7-inch	192	112	141	37		Wind			do		
727	C. Mensen Kamp	do	I-13	?1897	do	200		114	44		do			do		

Wells in the Anaheim quadrangle—Continued.

Number of well.	Owner.	Loc tio .	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
728	J. Kurtz	Santa Ana	J-13	1898	Bored, 7-inch	234	85	158	39		Wind			Domestic	
729	E. Meehan	do	J-13	1902	do	133	83	165	40		do			do	
730	H. W. Mills	do	J-13	?1896	do	137	93	160	32		do			do	
731	J. F. Snowden	do	J-13	1903	do	155		178	39		Gas	$300.00		do	
732	A. P. West	do	J-13	1903	Dug, 3-foot diameter.	263	96	168	42		Wind	210.00		do	
733	J. B. Shoemaker	do	I, J-12	1903	do	247	144	106	53		do	135.00		do	
734	W. H. Bass	do	I-12		Bored, 6-inch	259	Dry.	92			Not raised				
735	Olive Milling Co	do	I, J-12	1890	Bored, 7-inch	285	134	153			Steam			Domestic	
736	F. H. Meats	do	I-12	1903	do	225	118	170	47		Wind			do	
737	W. H. Stinchfield	do	I-12	1902	Dug, 3½ by 3½ feet; bored 8-inch, 20 feet.	222	115	106	49		do			do	
738	D. P. Crawford	do	I-11	1896	Bored, 7-inch	220	126	106	46		do			do	
739	Mary L. Paine	do	I-12	1903	do	215		124	45		do			do	
740	A. Peck	do	I-13	1894	do	196	146	155	37		do			do	
741	Olive road district	do	I-13	1901	do	198	111	186	37		Gas	240.00	$450.00	Roads	
742	H. Heim	do	I-12	1901	do	225	115	150	43		Wind			Domestic	
743	J. Timken	do	I-12	1904	do	209	111	118			Gas	177.00	150.00	do	
744	Taylor Bush	do	I-12	1900	Dug, 3-foot diameter.	206	110	98	51		Wind	49.00	85.00	do	
745	J. D. Heitshusen	do	H-12	1902	Dug, 3½ by 3½ feet, 90 feet; bored, 7-inch, 10 feet	203	107	100	51		do			do	

746	A. H. Robert	do	H-12	1903	Dug, 3-foot diameter, 90 feet; bored, 7-inch, 30 feet.	199	110	120	46		do	186.25	55.00	do	
747	Wm. Robbins	do	H-12	1899	Bored, 7-inch	197	Dry	95			Hand			do	
748	E. Tetzlaff	do	I-12	1902	Dug, 3 by 3 feet.	199	Dry	85			do			do	
749	J. R. Fletcher	do	I-12	1889	Bored, 7-inch	201	101	117	46		Wind			do	
750	Ben Dierker	do	H-12, 13	1902	Dug, 3-foot diameter.	196	108	90	32		do	85.00		do	
751	Paul Gatzke	do	H-13		Bored, 7-inch	194	Dry	86	32		do			do	
752	F. E. Robertson	do	H-13	1903	Dug, 3-foot diameter.	194	192	90	32		Hand			do	
753	Mrs. H. Adler	do	H-12	1898	Bored, 7-inch	196	95	103	42		Wind			do	
754	G. Kloth	do	H-13	?1889	do	183		95	38		Hand			do	
755	John Borchard	do	H-13	1901	Dug, 3-foot diameter, 60 feet; bored, 7-inch, 22 feet.	192	112	82	53		do			do	
756	T. M. Flippen	do	H-13	1898	Bored, 7-inch	183	102	100	43		do			do	
757	John Bunke	do	H-13	?1890	do	184		100	37		Wind; hand			do	
758	Jacob Bargsten	do	H-14	1891	do	172	103	72	41		Wind	98.00		do	
759	J. P. Kindt	San Juan Cajon	G-14	1900	Dug, 4-foot diameter.	159	92	69	40		do	95.00		do	
760	S. Hemmering	do	G-13	1903	Bored, 7-inch, 70 feet; 3-inch, 5 feet.	163	95	75	37		do	28.00		do	
761	J. A. Smith	do	F-14	1900	Bored, 10-inch	155	86	150	33		Gas	371.00	1,542.00	Irrigation	†60
762	do	do	F-14	1902	Bored, 7-inch	152		71	38		Wind	89.00	40.00	Domestic	
763	I. Clemens	do	F-14	1902	Bored, 10-inch	145	89	127			Gas	300.00	1,400.00	Irrigation	†70
764	do	do	F-14	1903	Bored, 7-inch	143	92	102	38		Hand	100.00	30.00	Domestic	
765	Wm. Green	do	F-14	?1884	do	141	90	86			Wind			do	
766	John Hanna	do	F-14		do	141	90	97	35		do			do	
767	Joe Fiscus	do	F-13	1897	Bored, 10-inch	146	92	123			Gas	166.70	1,775.00	Irrigation	
768	do	do	F-13	1901	Bored, 9½-inch	146	92	122			do	166.70		do	
769	Orange County	do	F-13		Bored, 7-inch	146	91	94	36		Wind			Roads	
770	Wm. Pannier	do	F-13	1897	do	152	92	75	44		do	72.00		Domestic	
771	do	do	F-13	1904	Bored, 10-inch	158	93	119			Gas			Irrigation	
772	do	do	F-13	1904	do	158	93	130			do			do	

Wells in the Anaheim quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
773	Wagner Bros	San Juan Cajon	G-12	1902	Bored, 10-inch	185	101	109			Gas	$158.00		Irrigation	†50
774	do	do	G-12	1904	do	185	101	122			do	85.00		do	
775	P. A. Dargett	do	G-12	1903	Bored, 7-inch	181	106	102	40		Hand	120.00		Domestic	
776	Mrs. M. E. Stanley	do	G-12	1903	Bored, 6-inch	180		88	38		Wind			do	
777	W. W. Scott	do	G-12	?1884	Bored, 7-inch	181	103	85	40		do			do	
778	do	do	G-12	1904	Dug, 6-foot, diameter, 73 feet; bored, 70-inch, 30 feet.	181	103	103	45		Gas	217.00		Irrigation	†25
779	C. D. Thompson	do	G-12	1901	Bored, 4 inch	182	106	80	41		Wind			Domestic	
780	Geo. Stanley	do	G-12	?1897	Bored, 6-inch	183	110	85	45		do			do	
781	G. Spingath	do	G-12	1902	Bored, 7-inch	182		106	43		Hand	120.00		do	
782	S. E. Wecker	do	G-12	1903	do	183		106	43		do	125.00		Domestic; stock	
783	John Berg	do	G-12	1901	Bored, 4-inch	182		98			do	100.00		Domestic	
784	do	do	G-12	1904	Bored, 10-inch	186	105	111			Gas	200.00	$1,375.00	Irrigation	†50
785	do	do	G-12	1898	Bored, 7-inch	186	105	108			do	131.00		do	
786	Peter Berg	do	G-12	1902	Bored (2), 10 inch	188	106	110	42		Gas (2)	600.00	2,000.00	Irrigation (2)	†75
787	W. Trapp	do	G-11	1902	Bored, 7-inch	192	110	101	43		Wind	111.00	60.00	Domestic	
788	do	do	G-11	1904	Bored, 10-inch	197	112	104			Gas	225.00	2,400.00	Irrigation	
788a	do	do	G-11	1904	do	197	112	112			do	225.00		do	
789	Wm. Wagner	do	G-11	?1897	Bored, 7-inch	185	110	80	42		Hand			Domestic	
790	Miller Scribner	do	F-13	1902	do	160	94	156	36		Gas	152.00	750.00	Irrigation	†25
791	C. L. Green	do	F-13	1901	do	153	95	101			do	88.07		do	
[illegible]	do	do	F-13	1901	do	153	95	84			do	71.48		do	

793	G. A. Hunter	do	F-12	?1879	Bored, 10-inch	164	102	248	43		do			do		85
794	do	do	F-12		Bored, 7-inch	158	99	85	39		Hand			Domestic		
795	Geo. Bauer	do	F-12	1901	Bored, 4-inch	170		99	38		do	95.00		do		
796	W. W. Terry	do	F-12	1900	do	170		83	45		Wind	65.00		do		
797	W. A. Ross	do	F-12		do	169	105	105	42		Gas			Domestic; irrigation.		
798	M. V. Stewart	do	F-12	?1900	Bored, 8-inch	172	104	106	44		do			Irrigation		†40
799	A. Gansmantel	do	F-12	?1897	Bored, 7-inch	169	104	89	42		Wind			Domestic; irrigation.		
800	H. Gebert	do	F-12	1901	Bored, 4-inch	173	105	104	46		Hand	60.00		Domestic		
801	F. M. Walber	do	F-12	1903	Bored, 7-inch	176	105	120	44		Gas		2,350.00	Irrigation		†75
802	do	do	G-12	1900	do	176	105	107	44	62	do			do		
803	do	do	F-12	?1898	do	175	106	107	43		do			Domestic		†3
804	A. H. Sheldon	do	F-12	1903	Bored, 6-inch	169	102	101			Not raised					
805	J. C. Ervines	do	F-12	1903	Bored, 4-inch	177	107	95	44		Wind	98.00	47.00	Domestic		
806	Wm. Herper	do	G-12	1903	Bored, 7-inch	179	107	100	42		Hand	100.00		do		
807	Edmund Henry	do	F-12	1901	Bored, 4-inch	178		90	48		do	*94.00		do		
808	M. L. Rogers	do	F-12		Bored, 7-inch	177	108	100	46		Wind			Domestic; stock		
809	A. Staehnke	do	F-12	1903	do	175	106	101	51		Hand			Domestic		
810	C. H. Thayer	do	F-12	1903	do	175	106	100	46		Gas	115.00	950.00	Irrigation		†25
811	Anaheim Cemetery	do	F-11		Bored, 8-inch	175	106	86	48		do			do		
812	G. L. Pickett	do	F-12	?1878	Bored, 7-inch	174	104	87	62		Wind			Domestic		
813	do	do	F-12	1901	do	174	104	108			Gas	122.00		Irrigation		†75
814	do	do	F-12	1901	do	174	104	101			do			do		
815	Mr. Fisher	do	F-12		do	169	104	86	42		Wind			Domestic		
816	L. S. Fletcher	do	F-12	1899	Bored, 4-inch	168		89	42		Wind, gas			Domestic; irrigation.		
817	M. A. Remick	do	F-12	1901	do	167	101		46		Wind			Domestic		
818	H. Kuebler	do	F-12	1898	Bored, 8-inch	167	101	96	44		do	96.00	40.00	do		
819	John Kuebler	do	F-12	1894	Bored, 6-inch	168	102	97			do	120.00		do		
820	W. T. McClellan	do	F-12	1904	Bored, 4-inch	155		80	42		Hand	54.40		do		
821	W. W. Weaver	do	F-12	1900	do	157		92	44		do	75.00		do		
822	J. Vetter	do	F-12	1902	do	157		82	43		do			do		
823	E. Kossert	do	F-12		Bored, 7-inch	158	100	83	40		Wind			do		
824	A. Schneider	do	F-12		do	154		85	41		do			do		
825	Mrs. N. J. Ramella	do	E-12	?1890	do	150	95	57			Hand			do		

Wells in the Anaheim quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
826	Oscar Renner	San Juan Cajon	E-12	1894	Driven, 1¼-inch	150		65	66		Hand			Domestic	
827	Max Früh	do	E-12	1893	Bored, 4-inch	150	96	65	47		Wind			do	
828	C. Stuckle	do	E-12	?1888	Bored, 7-inch	150	96	76	42		Hand			do	
829	do	do	F-12	1898	Bored, 4-inch	149		69	61		Wind			do	
830	D. Gervais	do	F-13	1903	Bored, 10-inch	148	93	102	39		Gas	$132.00	$2,011.00	Irrigation	†100
831	do	do	F-13	1904	do	148	93	103			do	168.00		do	
832	Mr. Kelley	do	F-13		Bored, 7-inch	135	90	79	43		Wind			Domestic	
833	J. C. Manerhan	do	F-13	?1897	Hydraulic, 2-inch	136		89	46		do	55.00		do	
834	do	do	F-13	1902	Bored, 10-inch	138	88	98			Gas	300.00	1,300.00	Irrigation	†100
834a	do	do	F-13	1902	do	138	88	104			do			do	
835	Ed. Kalf	do	F-13	1902	Bored, 7-inch	136	87	92	44		Hand	100.00		Domestic	
836	J. C. Schulz	do	F-13	1898	Bored, 3-inch	135		92	43		Wind			do	
837	Mrs. M. Newbauer	do	F-13	1902	Bored, 7-inch	130	89	99	45		do	106.00		do	
838	W. W. Mickle	do	D-13	?1890	do	129	89	100	68		do			do	
839	S. Holman	do	D-13	?1890	do	128	80	96	65		do			do	
840	A. Binder	do	D-13		do	130	89		75		do			do	
841	Fairview Water Co.	do	D-13	1903	do	131	89	303			Gas	418.00	1,930.00	Irrigation	135
842	do	do	D-13	1903	do	131	89	100			do	98.00		do	
842a	do	do	D-13	1903	do	131	89	101			do	98.00		do	
843	M. Neipp	do	D-13	1903	do	127	87	81	47		Wind	165.00		Domestic	
844	H. F. Kealiher	do	D-13	1902	do	124	83	100			Gas	100.00		Irrigation	†50
845	do	do	D-13	1903	do	124	83	100			do	100.00		do	

846	L. J. Johnson	do	D-13	1903	do	125	83	118	42		do	124.00	600.00	do		†15
847	H. F. Kealiher	do	D-13	1897	Bored, 4-inch	127	85	98	43		Wind	83.50		Domestic		
848	A. Hurtado	do	E-12, 13	1901	Bored, 3-inch	148		73	51		Hand	71.00		do		
849	R. Hermans	do	E-12, 13		Bored, 4-inch	148		76	47		Wind			do		
850	Mrs. Merideth	do	E-13	1901	Bored, 7-inch	148	94	101	40		do			Domestic; irrigation.		
851	F. Shanley	do	E-13	1896	do	148	96	94	42		do	94.00	45.00	do		
852	John Knutzen	do	E-13	1899	Bored, 4-inch	137	95	46			do			Domestic		
853	W. Berdrow	do	E-13		Bored, 8-inch	137	90	75	41		do			do		
854	Thos. Yaeger	do	E-13	1901	Bored, 4-inch	132		90	43		do	70.00		do		
855	Wm. Schwenckert	do	E-12	1903	Bored, 7-inch	138	90	100	41		Gas	88.00		Irrigation		†100
856	do	do	E-12	1903	do	138	90	98	41		do	86.40		do		
857	do	do	E-12	1880	do	135		90	45		Wind			Domestic		
858	P. C. Miller	do	D-12	1894	do	131	85	86	40		do	90.00		Stock		
859	do	do	D-12	?1880	do	129	84	84	43		do	90.00		Domestic		
860	G. J. Stock	do	D-13	1897	do	128	83	84	45		do	85.00		do		
861	W. R. Dickinson	do	D-13	1903	Bored, 4-inch	126		80	51		do			do		
862	A. Huch	do	D-13	1894	Bored, 7-inch	122	86	83	46		do	98.00		Domestic; stock		
863	C. G. Sparks	do	D-13	?1895	do	123	84	76	96		do			Domestic		
864	W. W. Adams	do	D-13	1898	do	125		96	86		do			do		
865	C. L. Carter	do	D-13	1900	do	120		100	80		Hand			do		
866	Mrs. Fay	do	D-13	1898	Bored, 10-inch	118		98	45		Gas, wind			do		†60
867	do	do	D-13	1898	do	118		101	45		Gas			do		
868	B. Heald	do	D-13	1902	Bored, 7-inch	120	87	130	43	66	do	130.00	700.00	Irrigation		†35
869	do	do	D-13	1891	Driven, 1¼-inch	120		50	43		Wind			Domestic		
870	do	do	D-13	?1894	Bored, 7-inch	121	88	100			do			Not used		
871	M. H. Litten	Los Coyotes	D-13	?1901	do	121	88	124	40		do			Domestic		
872	W. S. Tipton	do	D-12	1899	do	123		100	40		Wind, gas			Domestic; irrigation.		
873	B. W. Lentz	do	D-12	1902	Bored, 10-inch	123		137			Gas			Irrigation		†60
874	do	do	D-12	1902	Bored, 7-inch	123		137			do			do		
875	do	do	D-12		do	122	90	120	38		Wind			Domestic		
876	C. Macy	do	C-12	1903	do	116	86	85	73		do	95.00	50.00	do		
877	M. Lee	do	C-12	1903	Bored, 9¼-inch	114	85	182			Gas	2,500.00	905.00	Domestic; irrigation.		†50
878	Mr. Mardin	do	C-12	?1884	Bored, 7-inch	115	85	110	32		Hand			Not used		

Wells in the Anaheim quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
879	John Johnson	Los Coyotes	C-12	1900	Driven, 1¼-inch	114		30	102		Hand			Domestic	
880	M. O. Kellogg	do	C-13	1875	Bored, 7-inch	112	82	168	34		Wind			do	
881	M. H. Cheeseman	do	C-13	1903	do	109	83	110	45		do	$105.00		do	
882	Mrs. Johnson	do	C-13	?1899	Hydraulic, 2-inch	110	83		33		do			do	
883	C. Raab Creamery Co.	do	C-13	?1897	Bored, 2-inch	112		78			Steam			do	
884	A. S Escalle	do	C-13		Hydraulic, 1¼-inch.	112		90	74		Wind			do	
885	Charles Finch	do	C-13		Driven, 1¼-inch	112	86	37	63		Hand			do	
886	Ben Johnson	do	C-13	?1900	do	115	88	36	106		do			do	
887	Julius Baling	do	C-13	1898	Bored, 7-inch	111	85	92			Wind			do	
888	do	do	C-13	1891	Driven, 1¼-inch	109		46	63		do			do	
889	Henry Schultz	do	C-13	1898	Bored, 7-inch	106	82	94	39		do	93.00		Domestic; irrigation.	
890	do	do	C-13	1892	Driven, 1¼-inch	104		32	45		Hand			Domestic	
891	A. C. Bertram	do	C-13	1900	do	102		22	56		do			do	
892	C. H. Lee	do	C-13	?1880	Bored, 7-inch	100	76	200+	29		Wind			Domestic; irrigation.	
893	W. Bashove	do	B-13		Dug, 4-foot diameter.	92	77	16	43		Hand			Stock	
894	P. A. Stanton	do	B-13	1904	Bored, 10-inch	92	76	135	34		Gas	251.00		Irrigation	†40
895	do	do	B-13	?1890	Bored, 3-inch	85		128	34		Wind			Stock	
896	Mrs. Hein	do	B-13	1901	Bored, 7 inch	88	73	72	31		do			do	
897	Chas Sparks	do	B-13		do	90	72	150	29		do			do	
898	T. W. Dean	do	B-14	1900	Driven 1 inch	97		30	74		Hand			Domestic	

899	C. Whalley	do	B-12	1902	Bored, 7-inch	98	79	127	45	Gas	88.00	$250.00	Irrigation	†20
900	A. M. Ball	do	B-12	?1880	do	98	77	100	35	Wind			Domestic; irrigation.	
901	do	do	B-12	1903	do	98	77	125		Gas			Irrigation	†30
902	A. Messersmith	do	C-12	1900	do	104	78	129	35	Wind	200.00		Domestic; irrigation.	
903	E. L. Hein	do	C-12	1901	Bored, 4-inch	106		160	44	do			Domestic	
904	J. B. Pierce	do	B-12	?1884	do	96		96	32	do			do	
905	Magnolia school district.	do	B-12	1903	Bored, 7-inch	85		120	40	do	115.00		do	
906	A. W. Dearden	do	B-13	1903	do	91		176	60	Hand	180.00		do	
907	J. H. Boney	do	B-13	1899	do	85	70	180	40	Gas	200.00	600.00	Domestic; irrigation.	†20
908	A. Baker	do	B-13	1904	do	81	66	159		Not raised				
909	do	do	B-13	1895	Hydraulic, 2-inch	80		290	31	Horsepower	75.00		Domestic; irrigation.	
910	J. W. Martin	do	B-13	?1895	do	75	64	500	30	Wind, hand			do	
910a	do	do	B-13	?1895	do	75	64	225	30	do			do	
911	F. E. Mittlestet	do	A-13	1902	Bored, 7-inch	73		226		Gas	226.00	425.00	Irrigation	†30
912	do	do	A-13	1896	Bored, 2-inch	73		466		Wind	150.00		Domestic	
913	Miles Cox	do	A-13	?1892	Bored, 7-inch	75	65	288	28	Gas			Irrigation	†15
914	J. Seiditz	do	A-13	?1895	Bored, 2-inch	72	63	151	32	Wind			Domestic; stock	
915	J. Heiman	do	A-13	1894	Bored, 7-inch	78		505		Steam			Irrigation	†40
916	John Nichols	do	A-13	?1894	Bored, 2-inch	65		172	31	Hand			Domestic	
917	L. Bressel	do	A-13	1900	Bored, 7-inch	65		171		Gas	173.00	675.00	Irrigation	†50
918	do	do	A-13	1896	Bored, 2-inch	65		273	26	Wind			Domestic	
919	L. Schmidka	do	A-13	1897	do	68		296	28	do	75.00		do	
920	C. W. Cornwall	do	A-13	1904	Bored, 7-inch	70	62	92		Gas	110.00		Irrigation	†35
921	do	do	A-13	1903	Bored, 7-inch (2)	70	62	88		do	200.00		do	
922	do	do	A-13	?1897	Bored, 2-inch	70	64	500		Not raised				
923	do	do	A-13	1897	Bored, 7-inch	70		400	29	Hand			Domestic	
924	G. Dreger	do	A-12	1900	Bored, 2-inch	69	61	107	30	Wind	40.00		do	
925	J. Dreger	do	A-12	1899	Driven, 1¼-inch	70		156		Hand			do	
926	C. W. Brenner	do	A-12	?1892	Bored, 1¼-inch	70	66	200+	31	do			do	
927	Wm. Domris	do	A-12	1896	Bored, 2-inch	72	68	267	30	Wind			do	
928	do	do	A-12	1904	Bored, 7-inch	72	63	121		Not raised	118.00			

Wells in the Anaheim quadrangle—Continued.

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						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
929	Gus Linberg	Los Coyotes	A-12	1902	Driven, 1¼-inch	68	61	12	43		Hand			Domestic; stock	
930	Geo. S. Burrows	do	A-12		Bored, 2-inch	69	63	200			Not raised				
931	Wm Gebert	do	A-12	1899	Hydraulic, 2-inch	73		500			do	$175.00			
932	do	do	A-12	1901	Driven, 2-inch	72		15	47		Wind			Domestic; stock	
933	C. Remland	do	A-12	1898	Bored, 2-inch	73	68	260	29		do	103.00		Domestic	
934	C. Urbigkait	do	A-12	1903	Bored, 7-inch	74	64	108	30		do	120.00	$50.00	do	
935	L. W. Rains	do	A-12	1895	Driven, 2-inch	73		12	46		do			do	
936	G. T. Collier	do	A-12	?1894	Bored, 7-inch	77	65	480	25		Hand, horse-power.			Domestic; irrigation.	
937	Thos McGuire	do	A-12	1904	do	84	69	124			Not raised	116.00			
938	do	do	A-12	?1893	do	79	66	512			do				
939	do	do	A-12	1904	do	79	65	122			do	116.00			
940	Mrs. B. Masters	do	A-12	?1892	Hydraulic, 2-inch	77		125	29		Hand			Domestic	
941	do	do	A-12	?1894	Driven, 2-inch	80		30	42		Wind			do	
942	M. Schantz	do	A-12	1901	Bored, 7-inch	89	72	116	31		Hand			do	
943	J. E. Hart	do	A-12	1899	Bored, 10-inch	87	72	120	29		Gas			Irrigation	†25
944	do	do	A-12	1902	Driven, 1¼-inch	81		18	46		Wind			Domestic	
945	John Gustarfason	do	A-11	1897	Bored, 7-inch	87	72	125	31		do			do	
946	J. O. Brown	do	A-12		Bored, 2-inch	77		325	29		do			do	
947	E. B. Foster	do	A-11	1892	Bored, 7-inch	79	70	504	31		do	1,000.00		Stock	
948	do	do	A-11	1883	do	79	70	275			do			Not used	
949	do	do	A-11	?1898	Hydraulic, 2-inch	75		166	32		do			Domestic	
950	W. G. Potter	do	A-11	?1878	Bored, 7-inch	78	65	276			Not raised				

951	.....do	.....do	A-11	1875	.....do	74	.....	300	31	....	Wind			Domestic	
952	Mrs. Hahn	.....do	A-12	.....	Driven, 1¼-inch	72	.....	12	38	....	Hand			.....do	
953	Mrs. Burrows	.....do	A-12	?1890	Bored, 2-inch	69	60	225	29	....	Wind			.....do	
954	W. S. Taylor	.....do	A-11	1894	Driven, 1¼-inch	73	65	25	40	....	.....do			Domestic; stock	
955	W. G. Longhbro	.....do	A-11	1903	Bored, 7-inch	72	66	259	Gas	....		335.00	175.00	Irrigation	†17
956	.....do	.....do	A-11	?1896	Bored, 2-inch	72	.....	255	30	....	Wind	130.00		Domestic	
957	S. Milner	.....do	A-11	1899	.....do	71	.....	450	32	....	.....do	135.00		Domestic; irrigation.	
958	Malcolm Bros	.....do	A-11	1899	Bored, 8-inch	84	68	263	31	....	Gas			Irrigation	†25
959	.....do	.....do	A-11	.....	Hydraulic, 2-inch	84	.....	300+	31	....	Wind			Domestic	
960	C. C. Butterfield	.....do	A-11	?1895	Bored, 2-inch	88	.....	295	33	....	.....do			Domestic; stock	
961	.....do	.....do	B-11	1904	Bored, 12-inch	92	75	502	34	....	Gas	1,400.00		Irrigation	
962	Wm. Porter	.....do	B-12	1900	Bored, 7-inch	92	72	94	43	....	Wind			.....do	
963	P. Hussey	.....do	B-12	1903	.....do	95	.....	106	33	....	.....do	110.00		Domestic	
964	Wm. A. Green	.....do	B-12	1902	.....do	95	76	140	....	....	Gas	150.00	650.00	Irrigation	†11
965	.....do	.....do	B-12	1903	.....do	95	76	98	....	....	.....do	92.00		.....do	†23
966	Wm. Porter	.....do	B-12	.....	Bored, 4-inch	90	73	37	....	....	Wind			Domestic; stock	
967	T. Thowson	.....do	B-12	1898	Driven, 1¼-inch	88	.....	16	57	....	Hand			Domestic	
968	J. B. Crayne	.....do	B-12	1901	Bored, 7-inch	91	78	106	37	....	Wind			.....do	
969	Mrs. J. B. Cameron	.....do	B-12	1902	.....do	96	75	123	....	....	Gas	166.00		Irrigation	†25
970	.....do	.....do	B-12	1901	Bored, 4-inch	96	76	96	32	....	Wind			Domestic; stock	
971	L. Harling	.....do	B-12	1903	.....do	101	.....	92	28	....	.....do	58.90		Domestic	
972	H. Hodle	.....do	B-12	1903	Bored, 7-inch	100	78	109	32	....	Hand			.....do	
973	Geo. Lenz	.....do	B, C-12	?1899	.....do	105	82	90	33	....	Wind	80.00		Domestic; irrigation.	
974	A. Steinke	.....do	B-12	1901	Bored, 4-inch	106	82	95	31	....	.....do			Domestic	
975	E. D. Murphy	.....do	C-12	1903	.....do	106	82	89	40	....	Hand	69.00		Domestic; stock	
976	R. C. Hein	.....do	C-12	?1891	Bored, 7-inch	108	84	102	54	....	Wind			.....do	
977	P. A. Peterson	.....do	C-12	1903	Bored, 10-inch	108	80	112	....	....	Not installed	211.80			
977a	.....do	.....do	C-12	1903	.....do	108	80	118	....	....	.....do	224.20			
978	J. Hedges	.....do	C-11	1903	Bored, 7-inch	112	84	104	56	....	Gas	90.40		Irrigation	†25
979	.....do	.....do	C-11	1903	.....do	112	84	104	....	....	.....do	90.40		.....do	
980	.....do	.....do	C-11	1899	Bored, 4-inch	110	84	70	33	....	Wind			Domestic	
981	J. A. Simpson	.....do	B-11	1904	Bored, 7-inch	108	83	103	32	....	Gas	85.00		Irrigation	†17
982	.....do	.....do	B-11	1903	Bored, 4-inch	108	83	94	32	....	Wind	80.00		Domestic	
983	.....do	.....do	B-11	1899	Bored, 7-inch	110	82	130	35	....	.....do	133.00		Irrigation	

Wells in the Anaheim quadrangle—Continued.

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						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
984	C. W. Amy	Los Coyotes	B-11	?1890	Bored, 4-inch	103	84	65	31		Wind			Domestic	
985	M. C. Morgan	do	B-11	?1900	Hydraulic, 5-inch	101	80	175			Gas			Irrigation	† 18
986	do	do	B-11	?1900	Hydraulic, 6-inch (2)	101	80	80	33		do			do	
987	Mr. Spomg	do	B-11		Hydraulic, 2-inch	98		80	31		Hand			Domestic	
988	Mr. Humerlich	do	B-11		Driven, 1¼-inch	98		30	35		do			do	
989	S. Krueger	do	B-11	?1900	do	98		51	36		do			Domestic; stock	
990	Ed Kelley	do	B-11	?1894	Bored, 2-inch	100		68	35		Wind			do	
991	A. Humerlich	do	A, B-11	1892	Driven, 1¼-inch	90		30	35		Hand			do	
992	A. L. Glass	do	A-11	1901	Bored, 7-inch	87	70	408			Gas			Irrigation	† 40
993	do	do	A-11	?1896	Bored, 2-inch	87		413	33		Wind			Domestic	
994	P. A. Stanton	do	B-11	?1903	Bored, 7-inch	108	89	72	56		do			Domestic; irrigation.	
995	Brookhurst Ranch	do	C-11	?1887	do	113	87	169	31		do			Domestic; stock	
996	P. A. Stanton	do	C-11	1901	do	116	87	118	35		do			do	
997	do	do	C-11	1904	Bored, 10-inch	118	88	375			Gas	$550.00	$1,500.00	Irrigation	† 100
998	do	do	C-11	1898	Bored, 7-inch	118	90	199			do	228.85		do	† 40
998a	do	do	C-11	1898	do	118	90	225			do			do	
999	N. M. Barron	do	C-11	1903	do	114	86	140	43		Hand			Domestic; stock	
1000	Chas. Allgeyer	do	C-11	1904	do	114	92	94			Wind	94.00	45.00	do	
1001	F. H. P. Miller	do	C-11	1903	do	119	93	64	33		do	76.00	275.00	Domestic; irrigation.	
1002	D. A. Browning	do	C-11	1888	do	122	92	75	35		do	78.00		Domestic; stock	

1003	C. T. Blackfan	do	C-11	1897	Bored, 3-inch, 20 feet; 2-inch, 53 feet.	125		73	40		do			do	
1004	O. L. Matthew	do	D-11	1896	Bored, 2-inch	124		375	29		do			Domestic	
1005	G. H. Hatfield	do	D-11	1892	Bored, 7-inch	128	95	95	35		Gas	95.00	825.00	Domestic; irrigation.	†35
1006	do	do	D-11	1903	do	128	95	131	35		do	125.00		Irrigation	
1007	Mrs. C. C. Browning	do	D-11	1879	do	132		375	28		Not installed			Domestic; stock	
1008	do	do	D-11	1904	do	132	94	205	47		Electric motor	220.50		Irrigation	
1009	do	do	D-11	1904	do	132	94	105			Not installed	92.35		do	
1010	do	do	D-11	1904	do	132	94	105			do	92.35		do	
1011	J. G. Welch	San Juan Cajon	D-11	1904	Bored, 4-inch	136	94	95	33		Hand	85.00		Domestic	
1012	W. C. Heyman	do	D-11	?1897	do	130		80	31		Wind			Domestic; stock	
1013	E. Bushnell	Los Coyotes	D-11	?1898	Bored, 2-inch	126		75	42		do			Domestic	
1014	W. F. Sonneman	San Juan Cajon	D-11	?1897	do	127		80	39		do			do	
1015	H. Requarth	Los Coyotes	D-11	1902	Bored, 7-inch	126	90	80	42		Gas			Irrigation	†25
1016	Mrs. Reardon	do	C-12	1900	Bored, 9¼-inch	116		246			do			do	†45
1017	do	do	C-12		Driven, 1¼-inch	115			60		Hand			Domestic	
1018	E. Henry	do	C-12	1902	Bored, 4-inch	113	87	79	35		Wind	60.00		do	
1019	A. C. Spalding	do	C-12	1903	Bored, 7-inch	116	88	77	37		Hand	75.90		Domestic; stock	
1020	Truman Campbell	do	C-12	?1901	Bored, 9¼-inch	118	89	182	31		Gas	250.00	625.00	Irrigation; domestic.	†48
1021	A. Henry	do	C-12	1901	Bored, 6-inch	118	89	75	42		Hand	65.00		Domestic	
1022	M. M. Poole	do	C-12	1899	Bored, 7-inch	119	90	82	57		do			do	
1023	A. N. Henry	do	C-12	1870	do	120	89	320			Wind			do	
1024	do	do	C-12	1898	do	122	89	225			Gas	500.00		Irrigation	†75
1025	do	do	C-12	1897	do	122	89	600			do			do	
1026	Chas. W. Spooner	do	C-12		do	120	89	77	53		Hand			Domestic	
1027	W. E. Morsch	do	D-12		do	120	89	78	56		do			do	
1028	Fred Stankey	do	D-12	1902	Bored, 4-inch	122	81	78	58		Wind			do	
1029	Lewis Gleichner	do	D-12	1902	Bored, 7-inch	123		137	57		do	130.00		do	
1030	John Huhn	do	D-12	1899	Driven, 1¼-inch	125		40	66		Hand			Domestic; stock	
1031	F. H. Wessler	San Juan Cajon	D-12	1901	Bored, 3-inch	126		77	83		do	79.00		Domestic	
1032	V. Montgomery	do	D-12		do	126		78	42		do			do	
1033	B. J. Snodgrass	do	D-12	1902	Driven, 2-inch	127		47	78		do			do	
1034	D. Stark	do	D-12	?1889	Bored, 9¼-inch	127		160	38		Wind			Domestic; irrigation.	

Wells in the Anaheim quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
1035	G. Meger	San Juan Cajon	D-12		Bored, 7-inch	125	89	101	34		Wind			Domestic; stock	
1036	J. Newman	do	D-12	1903	Bored, 4-inch	125		120	48		Hand	$98.00		Domestic	
1037	J. W. Duckworth	do	D-12	1898	Bored, 4-inch, 60 feet; 2-inch, 44 feet.	125	85	104	44		Wind			do	
1038	Loara district school	do	D-12	1902	Bored, 4-inch	129		100	38		do			do	
1039	L. Bolz	do	D-12	1902	do	130		75	44		do			do	
1040	G. Betts	do	D-12	1902	Driven, 1¼-inch	130		40	63		Hand			do	
1041	G. Grenke	do	D-12	1903	Bored, 4-inch	126	85	132	43		do			do	
1042	Jacob Rinker	do	D-12	?1899	Hydraulic, 2-inch	133		108	45		do			do	
1043	F. Dettner	do	D-12		Bored, 7-inch	134	92	126	39		Wind			do	
1044	F. Henderson	do	D-12	1882	Hydraulic, 2-inch	133		55	57		Hand			do	
1045	H. Williams	do	D-12	1903	Driven, 1¼-inch	134		40	49		Wind			do	
1046	Mrs. S. Rees	do	D-12	1900	Bored, 8-inch	134		89	50		do			do	
1047	T. J. F. Boege	do	D-12	1886	Bored, 7-inch	136	96	92			do			do	
1048	do	do	D-12	1902	do	136	96	88	40		Gas	75.20	$300.00	do	
1049	Mr. Spencer	do	D-12		do	137	95	80	20		Hand			do	
1050	Union Brewing Co.	do	D-12	?1890	do	136	96	86	40		Steam			do	
1051	C. Bennerscheidt	do	D-12	1884	do	133	93	88	42		Hand			do	
1052	John Shaw	do	D-12	1900	do	129		103	43		Gas			Domestic; irrigation.	†30
1052a	do	do	D-12	1901	do	129		103	43		do			Irrigation	
1053	C. W. Marden	do	D-12	1903	Bored, 10-inch	128	91	125			Not installed	140.00			

1054	do	do	D-12	?1900	Bored, 7-inch	128	89	98	41		Wind	100.00		Domestic	
1055	Tim Carroll	do	D-12	?1880	do	130		115	37		Horsepower			Irrigation	
1056	Chas. Lange	do	D-12	1877	do	132	93	84	40		Wind			Domestic	
1057	Mrs. Fay	do	E-12	?1898	Bored, 8-inch	138	95	81	38		do			Domestic; irrigation.	
1058	do	do	E-12	1894	Bored, 7-inch	138		90			Gas			Irrigation	
1059	F. A. Korn	do	E-12	?1874	do	138	94	98			Hand			Domestic	
1060	F. A. Maurer	do	E-12	1880	do	138		95	43		Wind			do	
1061	W. H. Hunt	do	E-12	?1897	Driven, 1¼-inch	139		63	47		Hand			do	
1062	F. Mickle	do	D-12	1900	Bored, 7-inch	137	90	125	44		Wind	117.00		do	
1064	N. A. Bittner	do	D-12	?1896	Bored, 3-inch	138		79	40		do	45.00	45.00	do	
1065	Mrs. Felber	do	D-12	1899	Bored, 4-inch, 25 feet; 2-inch, 55 feet.	139		80	45		Hand			do	
1066	J. Everhardy	do	D-12	?1884	Bored, 7-inch	140		90	49		Wind			Domestic; irrigation.	
1067	F. A. Korn	do	D-12	?1880	do	140	94	87	49		Horsepower			do	
1068	W. G. Krutz	do	D-12	?1885	do	139	94	57	52		Wind			Domestic	
1069	W. A. Wallace	do	D-12	?1899	Bored, 4-inch	137		96	59		Gas			Domestic; irrigation.	
1070	J. McCorkindale	do	D-12	1903	Bored, 7-inch	136	97	99	49		do			Irrigation	†68
1070a	do	do	D-12	1901	do	136	97	99	49		do			do	
1071	do	do	D-12		Bored, 4-inch	136		80	61		Wind			Domestic	
1072	Chas. Eells	do	D-12	?1899	Bored, 7-inch	132	93	140	50		do			do	
1073	H. D. Young	do	D-12	1903	do	132	94	80	58		do			do	
1074	P. Boons	do	D-12	?1894	Driven, 1¼-inch	130		35	80		Hand			Domestic; stock	
1075	F. W. Fleischman	do	D-11, 12	1902	Bored, 7-inch	134		84	31		Gas			Domestic	13
1076	W. I. Carver	do	D-11	1903	do	140	98	79	38		Wind			do	
1077	do	do	D-11	?1903	do	142	98	79	39		Hand			do	
1078	do	do	E-11	1901	do	145	101	75			Gas			Irrigation	†22
1079	do	do	E-11	1901	Bored, 10-inch	145	101	86			do			do	
1080	Mrs. A. Frohling	do	E-12	1903	Bored, 3-inch	144		105	54		Wind	100.00		Domestic	
1081	A. Bittner	do	E-12	?1902	Bored, 7-inch	143	94	144			Gas			Irrigation	†75
1082	do	do	E-12	?1902	do	143	94	144			do			do	
1083	do	do	E-12	?1880	do	140	92	81	44		Wind			Domestic	
1084	J. L. Shumacher	do	E-12	?1899	do	139	93	90	45		do	77.00		do	

Wells in the Anaheim quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 1,000,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
1085	A. B. Markle	San Juan Cajon	E-12		Bored, 7-inch	139	93	81	40		Gas			Domestic; irrigation.	
1086	J. A Tyler	do	E-12		do	145	105	73	40		Wind			Domestic	
1087	G. Baumgart	do	E-12	1903	do	143	95	100	46		Gas	$91.00	$225.00	Domestic; irrigation.	
1088	Orphans Home	do	E-12		do	145	96	95	43		Wind			Domestic	
1089	C. O. Rust	do	E-12	1874	do	148	96	92	37		do			do	
1090	do	do	E-12	?1899	do	148	96	100	37		Gas	100.00		do	
1091	M. C. Langenberger	do	E-12	?1869	do	152	96	95	37		do			do	
1092	J. J. Snyder	do	E-11	?1863	do	148	99	69	37		Wind			do	
1093	J. A Eymann	do	E-11	?1865	do	148	99	80	35		do			do	
1094	Mrs. F. Dyer	do	E-11	1881	do	153	103	70	38		do			do	
1095	do	do	E-11	1903	do	153	104	110			Gas	101.00		Irrigation	†95
1096	do	do	E-11	1903	do	153	104	119			do	110.40		do	
1097	Mrs. N. G. Perry	do	E-11	1900	Bored, 4-inch	153		84	39		Wind	47.45	40.00	Domestic	
1098	A. R. Eddis	do	E-11	?1899	Bored, 3-inch	154		85	35		do			do	
1099	H. Wilke	do	E-11	1889	Bored, 7-inch	154	99	95	39		do			do	
1100	Mrs. J. Stoodtholl	do	E-11	?1870	do	154	103	90	37		do			Domestic; irrigation.	
1101	A. Backs	do	E-12		do	152	98		32		do			Domestic	
1102	Anaheim city	do	E-12	1896	Bored, 10-inch	153	99	112	39		Steam			do	
1103	do	do	E-12	1896	do	153	99	116	39		do			do	
1104	do	do	E-12	1896	do	153	99	120	39		do			do	

1105	Mr. F. Ruhmann	do	E-12		Bored, 7-inch	153	99	96	41		Wind			do	
1106	W. J. Fisher	do	E-12	?1898	Hydraulic, 2-inch.	150		90			do			do	
1107	Wm. Heying	do	E-12	?1901	Bored, 4-inch	149		88	41		do			do	
1108	H. Hussman	do	E-12	?1870	Bored, 7-inch	150		110	39		do			do	
1109	T. S. Grimshaw	do	E-12	1883	do	149		90	45		do			do	
1110	J. Bennerscheidt	do	E-12	1880	do	149		90	55		do			do	
1111	J. M. Roberts	do	E-12	1885	do	147	96	89	40		do			do	
1112	J. Bennerscheidt	do	E-12	?1884	do	148		90	38		do			do	
1113	M. Nebeling	do	E-12		do	149	96	73	40		do			do	
1114	R. Fossek	do	E-12	?1885	do	149	96	85	44		do			do	
1115	Wm. Konig	do	E-12	?1870	do	152	98	83	45		Horsepower			do	
1116	Colonel Hart	do	E-12		do	153	98	87	40		Wind			do	
1117	F. Bamn	do	E-12	?1888	do	153	99	83	40		do			do	
1118	H. A. Stough	do	E-12	1893	do	150	103	98	41		do			do	
1119	J. B. Rea	do	E-12	?1897	do	154	97	96	39		do			do	
1120	Mr. McWilliams	do	E-12	1893	do	155	100	88	45		do	96.00	40.00	do	
1121	P. J. Mercereau	do	E-12	1901	do	154	99	100	40		Gas			Domestic; irrigation.	
1122	Miss S. M. Zelen	do	E-12		Bored, 4-inch	154		90	34		Wind			Domestic	
1123	A. Rimpan	do	E, F-12	?1883	Bored, 7-inch	157	100	85	44		do			do	
1124	P. Stechert	do	E-12	?1888	do	155	99	92	43		do			do	
1125	Mrs. E. Pellegrin	do	E-12		do	154	98	100			do			do	
1126	J. E. Strehle	do	E-12		do	160	101	80	35		Horsepower			Domestic; irrigation.	
1127	E. F. Wyatt	do	E-12	1903	do	161		99	35		Gas	800.00	175.00	do	
1128	A. Becker	do	F-12		Bored, 4-inch	161		75	52		Wind			Domestic	
1129	A. Bissell	do	F-12		do	165		80	50		do			do	
1130	A. E. Susmil	do	F-12	?1899	do	167		78	53		Gas	69.75	150.00	Domestic; irrigation.	
1131	H. Kreger	do	F-12		Bored, 7-inch	168	101	87	39		Wind			do	
1132	H. Gunderson	do	F-12		do	169		92	38		Hand			Domestic; stock	
1133	L. J. Christopher	do	F-11	1903	do	169	105	90	39		do	92.00		Domestic	
1134	Wm. Kretschmer	do	F-11		do	168		100	40		Wind			do	
1135	J. H. Brunworth	do	F-11	?1889	do	168	103	101	31		do			do	
1136	Mrs. A. D. Adams	do	F-11	1903	do	169		92	35		Hand			do	

Wells in the Anaheim quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
1137	F. W. Beecroft	San Juan Cajon	F-11	?1894	Bored, 7-inch	169	103	103	35		Gas			Domestic; irrigation.	
1138	M Neblung	do	F-11		do	163	99	137	36		Wind			Domestic	
1139	James Shearer	do	F-11		do	162	99	86	42		do			do	
1140	A. W. Maxwell	do	E-11		Bored, 4-inch	161		90	32		do			do	
1141	do	do	F-11	1902	Bored, 10-inch	163	102	103			Gas	$103.00		Irrigation	†80
1142	do	do	F-11	1902	do	163	102	113			do	113.00		do	
1143	M A Smith	do	E-11		Bored, 7-inch	161	105	110	45		Hand			Domestic	
1144	J. E. Allen	do	F-11	1900	Bored, 4-inch	166		74	48		Wind			do	
1145	J. A. Aubert	do	F-11		do	166		96	49		Hand			do	
1146	Joe Roesler	do	F-11	1901	do	165		80	54		do	76.00		do	
1147	John Campbell	do	F-11	1900	Bored, 7-inch	166	103	94	33		Wind			do	
1148	Frank Edison	do	F-11	1896	do	166	102	96	41		do			Domestic; irrigation.	
1149	W. H. Yarger	do	F-11		do	166	102	71	45		do			Domestic	
1150	Mrs. Staley	do	F-11		do	178		86	39		do			do	
1151	W. I. Wilson	do	G-11	1889	do	185	108	83			do			do	
1152	J. B. McFarland	do	G-11		do	188	108	86	35		do			do	
1153	L. Parker	do	G-11		do	185	108	91	41		do			do	
1154	Mrs Staley	do	F-11	1903	Bored, 10-inch	178	108	103	42		Gas			Irrigation	†85
1155	do	do	F-11	1903	do	178	108	103			do			do	
1156	Thomas Ahern	do	G 11	1904	do	182		119			Not installed				
1156a	do	do	G 11	1904	do	182		127			do				

1157	E. Tucker	do	H-11		Bored, 7-inch	202	111	99	41		Wind			Domestic		
1158	A. Derksen	do	H-11	1901	Bored, 10-inch	208	114	100	47		do	196.00		do		
1159	Mrs. D. Berdich	do	H-11	1902	do	199	115	181	46		Hand	300.00		Domestic; stock		
1160	Orange County	do	G-12	1900	Bored, 7-inch	187		106			Gas			Roads		
1161	E. C. Conger	Santa Ana	I-11		do	227	140	142	68		Wind			Domestic		
1162	Passmore ranch	do	I-11	1893	do	245		51	96		do			do		
1163	do	do	I-11	1894	Dug, 3 by 4 foot	230	205	27	61		Hand			Stock		
1164	J. Watson	do	K-11	1903	Dug, 4-foot diameter.	262	193	77			Wind			Domestic		
1165	John Bush	do	K-11	1900	Dug, 3 by 4 foot	250	225	30	75		do			Domestic; stock		
1166	August Lemke	do	K-11	1902	Dug, 3 by 3 foot	249	196	57	48		Hand			do		
1167	Chris Lemke	do	K-11	1897	Dug, 3 by 4 foot	254	230	31	73		do			do		
1168	Mrs. V. Yorba	do	L-11	1903	Bored, 7-inch	300		196	86		Gas			Domestic; irrigation.		
1169	E. W. Pyne	do	M-10		Driven, 1¼-inch	325		25	66		Hand			Domestic		
1170	do	do	M-10		Bored, 4-inch	320	303	46	66		do			do		
1171	Beralta school district.	do	M-10	1900	Bored, 2-inch	315		100+	51		Wind			do		
1172	J. Bulliod	do	M-10		Dug, 3½ by 3½ foot	320	305	17	54		Hand			Domestic; stock		
1173	R. Cooper	do	N-10	1886	Dug, 3 by 3 foot	325	304	23	65		do			Domestic		
1174	Mrs. H. Bedoma	Canyon de Santa Ana.	M-10	?1877	Bored, 7-inch	275	222	62	65		Wind			Domestic; stock		
1175	D. M. Towne	do	M-10		Bored, 4-inch	263	Dry.	51			do			Domestic		
1176	Yorba school district.	do	L-10	?1899	do	267		68	61		do			Not used		
1177	Mrs. Yorba	do	L-9		Bored, 7-inch	270		49			do			Domestic		
1178	Geo. G. Bayha	do	L-10	1903	do	260	208	64	61		Gas			do		
1179	W. R. Carpenter	San Juan Cajon	H-10	1899	do	225	111	120	44		Hand	225.00		do		
1180	Beng. Kraemer	do	H-10	1900	do	220	115	146	38		Wind			do		
1181	E. M. Kraemer	do	H-10	1886	do	205	115	129			Not raised					
1182	do	do	H-10	1902	Bored, 10-inch	205	115	160	40		Gas			Irrigation		51
1183	Joseph Baxter	do	H-10	1904	do	198	110	187			do	400.00	$1,950.00	do		
1184	Wm. Crotther	do	H-10	1890	Bored, 6-inch	196	111	109	50		Wind			Domestic		
1185	Placentia school district.	do	H-9	1903	Bored, 7-inch	220		255	65		do			do		
1186	P. Hansen	do	H-9	?1878	do	225	136	130	67		do			do		
1187	Wesley Almes	do	H-9	1903	do	225	130	151	61		Hand	150.00		do		
1188	Joseph East	do	H-9	1894	Bored, 6-inch	245	161	124	83		Wind			do		

Wells in the Anaheim quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
1189	Saml. Kraemer	San Juan Cajon	H-9	1902	Bored, 7-inch	270	119	200	73		Wind	$310.00	$65.00	Domestic	
1190	Mr. Mesmer	do	I-9		do	283	200	139	57		do			do	
1191	W. B. Hervey	do	H-9		do	280	130	325	83		do			do	
1192	R. J. Laidlaw	do	I-9	?1897	Bored, 6-inch	310	222	275	71		do			Domestic; irrigation.	
1193	Jas. Stafford	Olinda	I-9	?1897	Bored, 7-inch	285	200	105	95		do			Domestic	
1194	J. W. Newell	do	J-9	?1896	do	312	245	180	90		do			Domestic; irrigation.	
1195	Santa Fe Oil Co.	do	J-8	1900	Bored, 10-inch	350	260	360	66		Steam			Oil wells	
1196	do	do	J-8	1901	do	350		260	45		do			do	
1197	do	do	J-8	1902	do	350		200	42		do			do	
1198	do	do	J-8	1903	do	350	260	195	38		do			do	
1199	Iowa Oil Co.	do	J-7	1902	Bored, 7-inch	378	258	200	73		do			Oil well	
1200	F. R. Holcome	San Juan Cajon	D-10	1890	Bored, 4-inch	132		69	71		Wind			Domestic; irrigation.	
1201	J. A. Vail	do	D-10	1892	do	130	107	76	48		do			do	
1202	J. Widdmer	do	D-9		Bored, 7-inch	135		175	55		do			Domestic	
1203	Mrs. A. Stone	do	E-10	1896	do	147	116	83	55		do			Domestic; irrigation.	
1204	Jacob Wintter	do	E-10	1882	Bored, 6-inch	143		146	37		do			Domestic	
1205	W. A. Barnes	do	E-10	1903	Bored, 7-inch	147	107	138	36		Hand	131.00		do	
1206	S. N. Fuller	do	D-10	1902	do	147	115	200+	42		Wind			do	
1207	E. Stone	do	D-10	1901	do	148	115	112	44		do			do	
1208	B. F. Porter	do	D-10	1892	do	136		95	50		do			do	

1209	Geo. F. Miles	do	E-11	1903	Bored, 10-inch	152	96	256			Gas	*3,000.00		Irrigation	†35
1210	do	do	D-11	1901	Hydraulic, 4-inch	145	103	114	29		Wind			Domestic	
1211	G. D. Houston	do	D-11		Bored, 4-inch	130	94	80	33		do			do	
1212	W. Ruderick	do	D-10		Bored, 7-inch	126	96	117	32		do			do	
1213	A. B. Johnson	do	D-10	1899	Bored, 4-inch	127	103	83	39		do			do	
1214	A. Goodwin	do	D-10	1884	Bored, 7-inch	127	102	350	38		do			do	
1215	J. H. Clever	do	D-9, 10	1899	do	147	102	181			Gas	*1,500.00		Irrigation	22
1216	do	do	D-9, 10	1891	Bored, 4-inch	145	100	68	66		Hand			Domestic	
1217	M. V. B. Lovering	Los Coyotes	D-10	1883	Bored, 7-inch	127	96	141	35		Wind			do	
1218	Alex. Gardner	do	D-10	1899	Hydraulic, 4-inch	125	104	167	30		Gas			do	
1219	W. H. Routzahn	do	D-10		Bored, 7-inch	124	91	200+	83		Wind			do	
1220	P. A. Nicholas	San Juan Cajon	D-10	?1888	do	132			42		Gas			Domestic; irrigation.	
1221	O. M. Skinner	Los Coyotes	C-10	1893	do	121	92	196	42		Wind	300.00		Domestic	
1222	Wm. Schulte	do	C-10	1876	do	119	92	135	38		do			do	
1223	M. A. Spencer	do	C-10	1892	do	119	91	136	42		do	160.00		do	
1224	I. A. Christlieb	do	C-10	1898	do	118	93	198	40		do			do	
1225	Smith Rancho Co.	do	C-10	1882	do	112	89	354	37		do			do	
1226	do	do	C-10	1885	do	112	89	581			Not raised				
1227	S. A. Bedell	do	C-10	1876	do	112	89	361	51		do				
1228	do	do	C-10	1904	Bored, 10-inch	112	89	365	65		Gas	850.00	1,000.00	Irrigation	†50
1229	Dean & Braly	San Juan Cajon	E-9	1898	Bored, 4-inch	155		145	55		Wind			Domestic	
1230	M. Cookson	Los Coyotes	B-10	?1892	Bored, 7-inch	86	76	235			Gas			Irrigation	
1231	do	do	B-10		do	86	76	267			do		2,000.00	do	†135
1232	do	do	B-10		do	86	76	278			do			do	
1233	do	do	B-10		do	87	76	240	39		Hand			Domestic; stock	
1234	J. W. Watson	do	A-9	?1882	do	75	75	175			Gas, artesian			Irrigation	†50
1235	do	do	A-9		do	75	75	175			do			do	
1236	do	do	A-10	?1882	do	75	75	200+	34		Artesian			Not used	
1237	do	do	A-10		Hydraulic, 3-inch	74	74	265	33		Wind			Domestic	
1238	Gus Hansen	do	B-10	1899	Bored, 7-inch	103	92	295			Not raised				
1239	do	do	B-10	1902	Bored, 10-inch	103	95	518			Gas	*2,200.00		Irrigation	37
1240	do	do	B-10	1894	Hydraulic, 2-inch	103	92	280	33		Wind			Stock	
1241	do	do	B-10	1900	Hydraulic, 3-inch	102	91	170	35		do			Domestic	
1242	Mr. Leonard	do	A-10	?1882	Hydraulic, 2-inch	78	72	200+	29		Hand			do	

Wells in the Anaheim quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
1243	J. Jones	Los Coyotes	A-10	1895	Bored, 6-inch	74	72	359	28		Hand	$600.00		Domestic	
1244	J. H. Wright	do	A-10	1893	Bored, 4-inch	74	72		33		do			do	
1245	Pacific Creamery Co.	do	A-10	1892	Bored, 7-inch	76	72	340	28	65	Steam			do	
1246	Geo. Wilcox	do	A-10	1892	do	76	72	190	31	65	Not raised				
1247	I. D. Jaynes	do	A-10		Bored, 6-inch	77	73	150			Gas			Irrigation	†40
1248	do	do	A-10	1890	Bored, 4-inch	76	72	137	34	65	Hand			Domestic	
1249	Los Lomas Rancho	do	B-9	?1898	Bored, 10-inch	95	92	1,000			Not raised				
1250	do	do	A-8	?1898	do	140	140	450	30	66	Artesian			Domestic; irrigation.	†15
1251	do	do	A-8		do	140	140	450	30	66	do			do	†3
1252	do	do	A-8		do	141	140	450			Not raised				
1253	J. T. Coleman	do	A-10		Bored, 7-inch	72	68	200+	42		Gas		$500.00	Irrigation	†40
1254	do	do	A-10		do	72	68	100			Not raised				
1255	Geo. H. Warren	do	A-10	1902	Hydraulic, 2-inch	75	71	365	56		Wind			Domestic	
1256	R. A. Sailor	do	A-10	1891	Bored, 7-inch	74	71	200+	25	66	Horse power			Domestic; irrigation.	
1257	J. E. Millikin	do	A-11	1894	Hydraulic, 2-inch	74	69	200	28	65	Gas			do	
1258	J. Yohn	do	A-11		do	74	66	150			Wind			Irrigation	
1259	do	do	A-11		do	74	66	135	35		do			Domestic	
1260	Wm. Goldie	do	A-11	1902	do	87	79	75	34		do			do	
1261	J. Kee	do	A-11	?1882	do	87	79	400+	35		do			do	
1262	E. D. Hiserodt	do	C-10	1900	Hydraulic, 3-inch	123	100	80	33	65	do	50.00		do	
1263	A. H. Gale	do	C-11	1902	do	124		60	59		do			do	

1264	J. E. Houston	do	C-11		Driven, 1¼-inch	123	103	40	61		do			Domestic; irrigation.	
1265	J. A. Clark	do	C-11	1904	Bored, 12-inch	123	94	350			Not raised	738.65			
1266	do	do	C-11	1901	Hydraulic, 3-inch	124	100	87	32		Wind			Domestic	
1267	J. Schneider	do	C-10	1896	do	123	105	86	35		do			do	
1268	S. K. Hollman	do	C-11	1894	Bored, 7-inch	115	91	180	31		do			do	
1269	A. E. Spreague	do	B-11	1890	do	105	87	200+	34		Gas			Irrigation	†25
1270	do	do	B-11	1900	Bored, 10-inch	105	87	200+	34		do			do	
1271	W. D. Smith	do	B-10	1897	Hydraulic, 2-inch	92	83	200	33		Wind			Domestic; irrigation.	
1272	I. R. Williams	do	B-11	1895	Bored, 4-inch	97	85	90	28		do			Domestic	
1273	do	do	B-11	1876	Bored, 7-inch	98	85	200			Not raised				
1274	W. S. Young	do	A-11	1901	Hydraulic, 4-inch	83	78	110	29	66	Hand			Domestic	
1275	do	do	A-11	1894	Hydraulic, 2-inch	83		412			Not raised				
1276	J. H. Bouvesruc	do	B-10	1898	Bored, 7-inch	90	79	212			Gas			Irrigation	†35
1277	do	do	B-10	1892	Hydraulic, 3-inch	90	79	212			do			do	
1278	H. H. Howell	do	A-10		Bored, 7-inch	84	76	400+			do			do	†25
1279	do	do	A-10		Driven, 1¼-inch	84	76	14	39		Hand			Domestic	
1280	Columbia Commercial Company.	do	D-9	1903	Bored, 7-inch	127	89	180			Gas			Irrigation	16
1281	do	do	D-9	1904	do	127	89	160			do			do	11
1282	Mrs. S. Rorden	San Juan Cajon	E-10	1884	do	150	114	166	49		Wind			Domestic	
1283	H. Burdori	do	E-10	?1882	do	154	114	200+	37		do			do	
1284	do	do	E-10	1904	do	160	109	132			Gas			Irrigation	
1285	do	do	E-10	1903	Bored, 10-inch	160	109	382			do			do	
1286	R. F. Parker	do	E-10	1899	Hydraulic, 3-inch	162	110	125	34		Wind			Domestic	
1287	A. Miller	do	E-10	?1882	Bored, 7-inch	163	110	82	34		do			do	
1288	Ed Sell	do	E-10	1899	Hydraulic, 3-inch	170	113	115	35		do			do	
1289	do	do	E-10	1902	Bored, 8-inch	169	113	160			Gas		800.00	Irrigation	
1290	A. Wright	do	F-10	1892	Bored, 7-inch	170	106	121	46		Wind			Domestic	
1291	W. A. Goodwin	do	F-10	1903	Bored, 6-inch	173	103	120	35		Hand			do	
1292	J. B. Harlow	do	F-10	1900	Hydraulic, 4-inch	174	105	96	45	65	do			do	
1293	B. Schumacher	do	F-10	1885	Bored, 7-inch	176	112	113	62	65	do			do	
1294	A. L. Michaeli	do	F-10		do	178	110	98	48	65	do			do	
1295	A. Porter	do	F-10	1903	do	178	108	114	40		Wind			do	
1296	Mrs. M. Selinger	do	G-10	1885	do	181	110	100	53		do			do	

Wells in the Anaheim quadrangle—Continued.

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						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
1297	A. Duffill	San Juan Cajon	G-10		Bored, 7-inch	195	108	202	49		Wind			Domestic	
1298	E. Krentz	do	F-10	1902	Hydraulic, 4-inch	169	103	93	34	65	Hand			do	
1299	W. B. Houston	do	F-10	1903	do	173	108	109	64	66	do			do	
1300	A. B. Annin	do	E-9, 10	1897	Hydraulic, 3-inch	170	128	142	49		Wind			do	
1301	T. J. McCart	do	E-9	1891	Bored, 10-inch	200	114	140	51		Gas			do	1½
1302	L. B. Benchley	do	E-9	1899	Bored, 7-inch	235	100	305			do	*$1,000.00		Domestic; irrigation.	6
1303	J. C. Sheppard	do	E-9	1891	do	173		107	73		Wind, gas			Domestic	
1304	Stearn & Goodman	do	E-9	1901	Hydraulic, 4-inch	173		100	48		Hand			Domestic; stock	
1305	H. W. Krug	do	F-9	1904	Bored, 10-inch	180	119	126			Gas			Irrigation	
1306	A. Block	do	F-9	1900	Hydraulic, 4-inch	184	112	124	102		Wind			Domestic	
1307	Touwsau Bros	do	E-9	1903	Bored, 10-inch, 230 feet; 7-inch, 70 feet.	235	100	300	48		Gas			Domestic; irrigation; stock.	
1308	do	do	E-9	1902	Bored, 7-inch	250	109	232			Not raised				
1309	J. C. Rogers	do	F-9	1899	Hydraulic, 3-inch	192		160	68		Hand			Domestic	
1310	O. des Granges	do	F-9	1900	Bored, 7-inch	198	113	183	51		Wind			do	
1310a	J. des Granges	do	G-9	1904	do	205		166			Hand			do	
1311	C. S. Knowlton	do	F-9	1884	do	192	110	123	72		do			do	
1312	J. J. Hunter	do	F-10	1882	do	165	103	125	48		Wind			Domestic; irrigation.	
1313	Mrs. Mary Hunter	do	F-10	1893	do	165	108	125	58		do			do	
1314	Santa Isabel Rancho	do	G-9, 10	1904	Bored, 10 inch	204	103	335			Gas, steam			Irrigation	
1315	do	do	G-9, 10	1882	Bored, 7 inch	202	106	125	70		Wind			Domestic	

1316	F. X. Dauser	do	G-10	1903	Bored, 12-inch	200	104	262			Gas			Irrigation	†35
1317	do	do	G-10	1896	Bored, 7-inch	199	105	108	76		Wind			Domestic	
1318	S. S. Twombly	do	F-9	1890	do	194	74	150	76		do			do	
1319	Mrs. Mattie Hansen	do	G-9	1883	do	207	106	115	88		do			do	
1320	Mrs. Tombes	do	G-9	1902	do	252	170	165			do			do	
1321	A. T. Pendleton	do	G-8	1900	do	267	173	187	107		do	222.50		Domestic; irrigation.	
1322	F. J. McFadden	do	G-8	1902	do	267		188	97		do			Domestic	
1323	J. R. Hinde	do	G-8	1876	Bored, 12-inch	283	188	113	94		do			do	
1324	J. K. Tuffree	do	H-8	?1878	Bored, 7-inch	284		190	49		Gas			Domestic; irrigation.	
1325	Jas. J. Ortega	do	H-8	?1888	do	182		200+	91		do			Domestic	
1326	J. N. Nenno	do	H-7	1903	Bored, 10-inch	365	232	550	62		do	1,500.00	$875.00	Domestic; irrigation.	
1327	Wm. Key estate	do	G-8	1900	Bored, 10-inch, reduced to 7-inch, reduced to 2-inch.	300	167	700	56		do			Domestic; stock	
1328	Thos. Strain	do	G-8	1901	Bored, 8-inch	322	132	329	54		do	545.00	1,300.00	Domestic; irrigation.	
1329	E. K. Clokke	do	G-8	1892	Bored, 3-inch	270		150	83		Wind			Domestic	
1330	F. B. Dunham	do	G-8	?1887	Bored, 7-inch	255	173	123	73		do			do	
1331	D. Hetchbrink	do	G-9	1901	Bored, 4-inch	235		153	88		do	154.00	55.00	do	
1332	Henry Hetchbrink	do	G-9	1886	Bored, 7-inch	248	158	130	86		do			do	
1333	W. F. Coulter	do	G-9	1899	Bored, 4-inch	223	127	130	96		do			do	
1334	E. Utt	do	F-6	?1899	Bored, 7-inch	380	313	97	57		do			Domestic; stock	
1335	E. Ford	do	F-6		do	364	306	100	102		do			Domestic	
1336	do	do	F-6	1903	Bored, 10-inch	372		185			Gas			Irrigation	5
1337	E. Utt	do	F-6	1904	Bored, 7-inch	375	302	320			do	800.00	700.00	do	
1338	Mr. Green	do	E-6		Dug, 3 by 3 foot	320	295	27	57		Hand			Domestic	
1339	S. W. Baldwin	do	E-5	1901	Bored, 8-inch	356	261	199	68		Gas	258.50	947.00	Irrigation	†10
1340	G. W. King	do	E-6	1901	Bored, 10-inch	315	278	345	52		do			do	†30
1341	M. C. Dodge	do	E-5	1898	Bored, 7-inch	352	260	160	70		Wind	201.00		Domestic	
1342	Union Oil Co	do	E-5	1902	do	338		400			Compressed air			Oil wells	†10
1343	Union Oil Co	do	E-5		Bored, 8-inch	338	270	170			Not raised				
1344	Mr. Chenney	do	E-5		Bored, 7-inch	335	269	81	54		Wind			Domestic	
1345	E. H. Stone	do	E-6	?1897	do	335			40		do			do	

Wells in the Anaheim quadrangle—Continued.

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						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
1346	Jack Hunter	San Juan Cajon	D-6		Bored, 7-inch	327	272	76	56		Wind			Stock	
1347	J. Good	do	D-6	1903	do	310		90	58		Hand	$107.00		Domestic	
1348	T. P. Warne	do	D-5	1895	Bored; 4-inch	328		100	61		Wind			do	
1349	La Habra School District.	La Habra	D-5		Bored, 7-inch	325		90	45		do			do	
1350	C. H. H. Parker	do	D-5	1900	Bored, 10-inch	327	277	118	52	71	do	150.00	$225.00	Domestic; irrigation.	
1351	F. R. Aldrich	do	D-5	1896	Bored, 7-inch	350	130		42		do			Domestic	
1352	J. M. Cusick	do	D-5		Bored, 2-inch	370	?220	537	70		do			do	
1353	C. J. Proud	do	D-5	1902	Bored, 10-inch	352	272	430			Not installed			Not used	
1354	F. W. Bishop	do	D-4	1901	Bored, 7-inch	400	200	236	44		Wind			Domestic	
1355	A. L. Roache	do	C-4		Bored, 10-inch	475		265	75		do			do	
1356	do	do	C-4	1900	Bored, 12-inch	475	225	600+			Gas			Irrigation	†17
1357	D. Bastanchury	San Juan Cajon	E-7		Dug, 5-foot diameter.	305	254	53	81		Wind			Domestic; stock	
1358	do	do	E-7	1904	Bored, 12-inch	327		892	70		do			Domestic; irrigation.	
1359	I. B. Varney	La Habra	D-6		Bored, 6-inch	301		100	65		do			do	
1360	C. W. Leffingwell	Santa Gertrudis	A-4	1898	Bored, 10-inch	265	173	583			Compressed air			Irrigation	35
1361	do	do	A-4	1896	do	255	185	282			do			do	10
1362	do	do	A-4	1900	Hydraulic, 3-inch	265	165	605			Gas			do	†3
1363	do	do	A-5		Dug, 3 by 3 foot	247	190	60			Wind			Domestic	
1364	do	do	A-5		Bored, 12-inch, 700 feet; 9½ inch, 207 feet.	260	188	907			Not raised				

1365	W. W. Dowell	La Habra	A-4		Bored, 7-inch	305	220	190	67		Wind			Domestic	
1366	J. R. Dyer	do	A-4		do	324	205	140	71		do			do	
1367	Scott George	do	B-4	1898	Hydraulic, 3-inch	374	194	537			Not raised				
1368	W. H. Landieth	do	B-5	1899	Bored, 6-inch	360	285	500			Compressed air			Not used	
1369	H. Bush	do	B-5	1896	Hydraulic, 4½-in.	332	234	165	65		Wind			Domestic	
1370	S. M. Smith	do	B-5	1899	Bored, 10-inch	335	252	450			Gas	1,150.00	1,000.00	Irrigation	†30
1371	do	Los Coyotes	B-5	1897	Bored, 7-inch	320	220	140	67		Wind			Domestic	
1372	do	do	B-5	1899	Bored, 8-inch	320	220	200			do			Not used	
1373	Mr. Session	do	B-6		Bored, 7-inch	288	249	162	67		do			Domestic	
1374	J. L. Toler	do	B-6	1875	do	310	165	185	75		do			do	
1375	T. B. Cooper	do	B-6	1904	do	298	247	173	88		Hand			do	
1376	J. A. Gill	do	C-6	1903	do	295	245	123	81		Wind			Domestic; irrigation.	
1377	T. L. Jackson	La Habra	C-5	1900	do	325	285	99	52		do			do	
1378	Jos. Schrott	do	C-5	?1899	Bored, 6-inch	362	252	160	57		do			Domestic	
1379	C. L. McComber	Los Coyotes	A-8	1901	Bored, 5-inch	110	110	285	30		Gas, artesian			Irrigation	†30
1379a	do	do	A-8	1903	Bored, 10-inch	110	105	285			Gas			do	
1380	Tom McFadden	La Habra	D-5	?1903	Dug, 3½-foot diameter.	300	282	19	70		Hand			Domestic	
1381	J. G. Lanner	do	D-5	1898	Bored, 8-inch	320		80	43		Wind, gas			Domestic; irrigation.	
1382	R. C. Hiatt	do	D-5		Bored, 6-inch	312	276	68	45		Wind			Domestic	
1383	H. A. McDonald	do	C-5	1904	Bored, 7-inch	323		120	68		do	147.00	75.00	Domestic; irrigation.	
1384	H. E. Hart	do	C-5		do	328		145	45		do			Domestic	
1385	Thos. Dawson	do	C-5	?1899	do	327	271	80	38		do			do	
1386	C. O. Cook	do	C-5		do	330	271	126	60		Gas			Domestic; irrigation.	
1387	Mrs. Arfwedson	do	C-5		Bored, 8-inch	328	270	109	49		Wind			do	
1388	Harry Little	do	C-5		Bored, 7-inch	310	271	102	64		do			do	
1389	F. D. Chaffee	do	C-6	1897	Bored, 6-inch	295	258	87	82		do	78.00		Domestic	
1390	Mr. Baldwin	do	D-6	1902	Dug, 4-foot diameter.	315	266	54	81		do			do	
1391	J. Leutwiler	do	C-6	1899	Bored, 8-inch	285	251	88	78		do	85.00		do	
1392	J. Leuhm	do	C-5	1897	Bored, 10-inch	305	258	101	73		do			do	
1393	A. L. Roach	do	C-6	1901	Dug, 6 by 6 foot	262	262	30	95		Gas, wind, artesian.			Domestic; irrigation.	†2

Wells in the Anaheim quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
1394	A. L. Roach	La Habra	C-6		Bored, 4-inch	262	262	600+	94		Gas, artesian			Irrigation	
1395	M. A. St. Clair	La Puente	H-1	1901	Bored, 10-inch	550	509	100	35	70	Wind	$80.00	$65.00	Domestic; stock	
1396	F. Grazide	do	H-1	1900	Bored, 9¼-inch	515	488	83	33	70	Gas			Irrigation	†50
1397	J. Ybarra	do	H-1	1894	Dug, 4 by 4 foot	525	487	40			Wind		200.00	Domestic; stock	
1398	W. McClintock	do	H-1	1902	Bored, 9¼-inch	542	508	64	35		Gas	75.00		do	2
1399	Valentine Paton	do	H-1	1901	do	525		58	35	69	Flows into tunnel.				
1399a	do	do	H-1	1901	do	525		60	35	69	do				
1399b	do	do	H-1	1901	do	525		72	35	69	do	400.00	a 8,000.00	Irrigation	†100
1399c	do	do	H-1	1902	do	525		80	35	69	do				
1399d	do	do	H-1	1902	do	525		90	35	69	do				
1400	J. Ybarra	do	H-1	1901	Bored, 10-inch	505	486	70			Gas	75.00	400.00	do	
1401	C. B. Ybarra	Rincon De La Brea	H-1		Dug, 4 by 3½ foot	525	511	18	60	70	Wind			Domestic; irrigation.	
1402	J. M. Chavy	La Puente	H-1	1904	Dug, 4 by 4 foot	475	459	18	38		do			Domestic	
1403	W. H. Howell	Rincon De La Brea	G-1	1899	Bored, 10-inch	475	460	65	45	68	Gas			Irrigation	†55
1404	A. E. Kepner	La Puente	G-1	1900	do	480	460	85			do	100.00	500.00	do	
1405	B. F. Rowland	do	E-1	1897	do	425	400	270			do		1,725.00	do	†160
1405a	do	do	E-1	1897	Bored, 10-inch (2)	425	400	110			do			do	
1406	do	do	E-1		Bored, 7-inch	405	367	67	61		Wind				
1409	F. Grazide	do	F-2	1903	Bored, 12-inch	500	465	70	68		Gas			Domestic; irrigation.	†10
1410	S. A. Middagh	do	G-1	1901	Bored, 10-inch.	495	468	70			Wind			Not used	

a Cost of tunnel and shafts.

Wells in the Santa Ana quadrangle.

[* Cost of well and machinery. † Estimated. + Including tank in column "Cost of machinery". ? Doubtful.]

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
1	A. A. Mallett	Las Bolsas	A-1	1876	Bored, 7-inch	30	30		36		Artesian			Domestic; irrigation; stock.	7
2	J. J. Pyle	do	A-1	1875	do	27	27	107	33	64	do	$105.00		Stock	42
3	O. B. Byram	do	A-1	1875	do	30	30	107	30		do	105.00		Domestic; irrigation; stock.	
4	do	do	A-1	1889	Hydraulic, 3-inch	30	30	110	32		do	57.75		Irrigation	5
5	G. W. Mack	do	A-1	1889	Hydraulic, 2-inch	30	30	110	32		do			do	
6	do	do	A-1	1894	Bored, 7-inch	29	29	107	31		do			Domestic; stock	
7	W. J. Edwards	do	A-1	1875	Bored, 6-inch	33	33	172	30		do			do	22
8	H. R. Case	do	A-1	1900	Hydraulic, 2-inch	27	27	115	33		do			Irrigation; stock	
9	do	do	A-1	1888	Bored, 7-inch	27	27	119	32		do			Domestic; stock	
10	do	do	A-1	1900	Hydraulic, 2-inch	27	27	110			do			Domestic; irrigation.	8
11	J. H. Birch	do	A-1	1888	Bored, 7-inch	28	28	108	33		do	125.00		Domestic; stock.	12
12	do	do	A-1		Bored, 4-inch	28	28	111	33		do			Domestic	
13	Baily Cook	do	A-1	1884	Bored, 7-inch	37	37		33		Artesian, wind			Domestic; stock	
14	do	do	A-1	1900	Hydraulic, 1½-inch.	35	35	114	33		Artesian	30.00		Stock	
15	W. J. Edwards	do	A-1	1900	do	35	35	114	33		do	30.00		do	2
16	do	do	A-1	1896	Bored, 7-inch	32	32	118	33		do	100.00		Domestic; stock	
17	do	do	A-1	1897	Driven, 4-inch	32	32	114	32		do			do	9
18	do	do	A-1	1879	Bored, 7-inch	32	32	110	33		do			Stock	7

Wells in the Santa Ana quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
19	A. A. Mallett	Las Bolsas	A-1	1876	Bored, 7-inch	30	30				Artesian			Stock	
20	E. D. Linder	do	A-1	1892	do	32	32	108	32		do			Domestic	
21	E. C. Phelps	do	A-1		do	35	35	125	30		do			Irrigation	
22	do	do	A-1		Bored, 3-inch	35	35		32		do			do	
23	J. H. Metzgar	do	A-1	1892	Bored, 2-inch	36	36	112	33		do			Domestic; irrigation; stock.	
24	do	do	A-1		do	37	37		31		do			Irrigation	
25	Dan Head	do	B-1		Hydraulic, 2-inch	38	38		33		do			do	
26	do	do	B-1		do	38	38		32		do			do	
27	Sterling Price	do	B-1	1901	Bored, 4-inch	39	39		34		do			do	14
28	do	do	B-1	1899	Bored, 6-inch	39	39	107	33		do			Stock	
29	do	do	B-1		Hydraulic, 2-inch	40	40	71	34		do			Domestic; stock	3
30	do	do	B-1		Bored, 4-inch	41	41	79	33		do			do	
31	do	do	B-1		do	43	43	110	34		do			Domestic	
32	Mr. Cowtin	do	B-2		Bored, 7-inch	44	44		33					Domestic; stock	
33	C. C. Johnson	do	B-1	1900	Hydraulic, 2-inch	44	44		33		Artesian			do	
34	B. M. Watts	do	B-1	1884	Bored, 8-inch	45	45	90	32		do			do	
35	F. R. Hazzard	do	A, B-1	1894	Bored, 7-inch	45	45	140	33		Siphon			Domestic; irrigation; stock.	
36	Durand estate	do	B-1		do	46	46	124	35		Artesian			Irrigation; stock.	2
37	do	do	B-1		do	46	46	129	32		Siphon			do	
38	German-American Bank	do	B-1		Bored, 4-inch	44	44	126	32		Artesian			Domestic; stock.	8

[illegible]	[illegible]	do	C-1		do	49	49	100	32		do			Stock	
40	W. G. Jones	do	B-1	1880	Bored, 7-inch	50	50	120	33		Wind			Domestic; stock	
41	do	do	B-1	1898		49	49	128	32		Artesian			Irrigation	
42	do	do	B-1	1894	Bored, 7-inch	49	49	142	32		Siphon			do	
43	Earnest Ward	do	C-1	1898	do	58	52	135	21		Not raised			Not used	
44	G. B. Grove	do	B-1	1879	do	52	52	97	33		Flows into pit			Irrigation	
45	Earnest Ward	do	B, C-1	1884	do	53	53	112	33		Hand			Domestic	
46	G. B. Grove	do	B-1		Bored, 4-inch	53			31		do			Domestic; stock	
47	Peter Ulrich	do	C-1	1896	Hydraulic, 2-inch	49	49	96	32		Artesian			Domestic	
48	P. J. Milton	do	C-1	1896	Bored, 4-inch	50	50	104	31		do	$100.00		Domestic; stock	3
49	Bolsa school district	do	C-1		do	50	50		33		do			Domestic	
50	J. H. Wertz	do	C-1		Hydraulic, 2-inch	49	49		32		do			do	
51	Mr. Head	do	C-1		Bored, 4-inch	49	49	127			do			Irrigation; stock	3
52	Samuel McCoy	do	C-1		do	49	49	106	31		do			Domestic; stock	
53	do	do	C-1		Bored, 7-inch	50	50	108	32		do			Stock	2
54	J. A. Connor	do	C-1	1876	Bored, 4-inch	48	48	101	33		do			Domestic; stock	
55	Mr. Cooper	do	C-1		do	48	48		33		do			Stock	
56	John Warren	do	C-1		Bored, 7-inch	48	48	110	33		do			Domestic; stock	2
57	W. D. Junkin	do	C-1		Hydraulic, 2-inch	49	49		33		do			do	
59	C. H. Hartle	do	C-1	1900	do	51	51	112	33		do			do	
60	do	do	C-1	1902	do	51	51	128	33		do			Irrigation	
61	do	do	C-1	1897	Bored, 4-inch	50	50	105	32		do			do	
62	J. E. Palla	do	C-1		do	50	50		32		do			Domestic; stock	
63	W. M. Crum	do	C-1	1898	Bored, 2-inch	50	50		34		do			do	
64	Mrs. Mary Ward	do	C-1	1890	do	50	50	100			Hand, artesian			do	
65	C. R. Ward	do	C-1		Bored, 7-inch	52	52		32		Artesian			Stock	
66	Harry West	do	C-1	1884	Bored, 4-inch	57	57	116	34		do			do	
67	C. C. Fife	do	C-1	1889	do	54	54	75	25		Hand	75.00		Domestic	
68	J. Dilley	do	C-1	1889	Bored, 7-inch	54	54	106	33		do	175.00		Domestic; stock	
69	do	do	C-1	1870	do	54	54		26		Not raised			Not used	
70	J. D. Price	do	D-1	1881	do	65	53	120	42		Wind	125.00	+$85.00	Domestic; stock	
71	S. Q. Conkle	do	D-1	1890	Bored, 4-inch	60		104	37		do	104.00	71.00	do	
72	John Newell	do	D-1			58		60+	33		do			do	
73	Geo. N. Shore	do	D-1		Bored, 4-inch	58	55		31		do			do	

Wells in the Santa Ana quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
74	A. Leatherman	Las Bolsas	D-1	1890	Bored, 4-inch	60	55	112	37		Horsepower		$160.00	Domestic; stock	40
76	Moter Helney	do	D-1		do	55	54	87			Wind			Not used	
77	Mr. Addington	do	D-1		do	53	53		34		Artesian			Stock	
78	J. M. Wallace	do	D-1		do	52	46		35		Wind			Domestic; stock	
79	J. E. Hodges	do	D-1	1890	do	52	43	125	39		Hand	$110.00		do	
80	E. B. Lunsford	do	D-1		do	50	44		33		Wind			do	
81	Mr. Blackburn	do	D-1	1895	Bored, 2-inch	50		112	35		do			Domestic	
82	J. W. Vawter	do	D-1	?1892	Bored, 7-inch	50		390	35		do			Domestic; stock	
83	do	do	D-1	1900	do	55	48	165	27		Gas	188.00	300.00	Irrigation	†20
84	W. A. Plument	do	D-1		Bored, 4-inch	49			37		Hand			Domestic; stock	
85	A. J. McArthur	do	D-1	1897	Hydraulic, 2-inch	55		165	23		Wind	70.00	55.00	do	
86	E. A. Teal	do	D-1	1886	Bored, 4-inch	58	46	?140	27		do			Domestic	
87	Elizabeth Rosemeyer	do	D-1	1890	Bored, 7-inch	55	47	150	40		Hand			Domestic; stock	
89	J. D. Price	do	E-1	1892	Bored, 4-inch	58	?46	107	25		do	95.00		Stock	
90	Orange Co	do	E-1	1900	Bored, 7-inch	55	47	150			Horsepower			Not used	
91	C. W. Blankenbeckler	do	E-1	?1884	do	55	47	117	39		Wind, hand			Domestic	
92	Alexander Alec	do	E-1	1891	do	55	48	150	33		Hand			do	
94	Joe McCormick	do	E-1	1890	Bored, 4-inch	60	48		38		do			Domestic; stock	
95	Mrs. Chrisp	do	E-1	1889	do	55	47	150	42		Wind, hand			do	
96	Mr. Wallace	do	E-1	1903	Bored, 7-inch	53		86	3[illegible]		Hand			Stock	
97	J. F. Stacey	do	E-1	1890	Bored, 4-inch	56	47	168	32						
98	Mr. Head	do	E-1	1901	do	52	49		40		Wind			Stock	

99	R. Pyke	do	E-1	1899	do	50	46	?150	36		do			Domestic; stock	
100	L. M. Steck	do	E-1			49			34		Steam			do	
101	N. N. Farlow	do	E-1	1898	Bored, 4-inch	50	46	115	39		Wind	115.00	60.00	do	
102	do	do	E-1	1898	do	49	45	83	43		Wind; gas	83.00	60.00	Irrigation	
103	Mrs. James Stanley	do	E.1	1896	do	49		130	42		Wind		100.00	Domestic; stock	
104	G. W. Hollister	do	E-1	?1879	do	49	46	111	39		do	50.00	10.00	Domestic; irrigation; stock.	
105	R. M. Phenneger	do	E-2	1878	Bored, 6-inch	47	47		43		do			Domestic; stock	
106	P. De Rosa	do	E-1, 2	1880	Bored, 4-inch	48					Hand			Stock	
107	E. I. Tolle	do	E-2	1874	do	47			43		do			do	
108	Geo. W. Clark	do	E-2	1892	do	48		?110	39		do			Domestic; stock	
109	Wm. Morgan	do	E-2			47		200+	29		Wind			do	
110	E. A. Matthis	do	E-2	1904	Dug, 3 by 3 feet	44	36	9	103		Hand			Domestic	
111	J. S. Dameron	do	E-2	1880	Bored, 7-inch	44	42	130	39		do			Domestic; stock	
112	J. Howard Bell	do	E-2		Bored, 4-inch	43	41		41		do			Stock	
113	M. A. Groom	do	E-2	1890	do	45	43	150	36		Wind	175.00	40.00	Domestic; stock	
114	R. P. Mitchell	do	E-2	1902	Bored, 2-inch	45		104	43		Hand	50.00		Domestic	
115	New Hope school district.	do	E, D-2	1885	Bored, 4-inch	45	42	150	37		do			do	
116	Walter D. Lamb	do	D-2	1880	Bored, 3-inch	45	41	104	40		Wind		65.00	Domestic; stock	
117	do	do	D-2	1883	Bored, 5-inch	46	42	130			Not raised			Not used	
118	do	do	D-2	1896	Bored, 4-inch	46	41	111			do			do	
119	A. L. Jesse	do	D-2	?1901	do	46	41	135	35		Wind			Domestic	
121	Mr. Kinsel	do	D-1	1902	Bored, 7-inch	48	43	156	32		Hand			do	
122	A. J. Addington	do	D-1	1886	Bored, 4-inch	48	38	100	39		do			Domestic; stock	
123	F. E. Anderson	do	D-2		Bored, 2-inch	45	42	130	34		do			Domestic	
124	do	do	D-2		Bored, 4-inch	45	42	130			Not raised			Not used	
125	D. E. Jessee	do	D-2	1899	Hydraulic, 2-inch	44	42	120	39		Wind	50.00	18.00	Domestic; stock	
126	do	do	D-2		Bored, 4-inch	43	43	100	35		Artesian			Stock	
127	T. E. Chantry	do	D-2		Bored, 7-inch	45	43				Not raised			Not used	
128	J. Willetts	do	D-2		Bored, 4-inch	44			37		Wind			Domestic; stock	
129	N. Bower	do	D-2	?1892	do	44	44	106	33		Artesian			do	
130	J. C. Jones	do	D-2	1898	Hydraulic, 3-inch	45	42	120	31		Hand			do	
131	C. W. Warner	do	D-2	1898	Bored, 4-inch	45	41	?116	31		Wind	86.00	20.00	do	
132	Marshall Vawters	do	D-2	1898	do	46	42	258	29		Wind; hand			do	
133	Henry Davis	do	D-1	1903	Driven, 1¼-inch	49		15	37		Hand	5.00		Domestic	

Wells in the Santa Ana quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
134	A. Jessee	Las Bolsas	D-1	1897	Hydraulic, 2-inch	49		115	39		Hand	$47.00		Domestic; stock	
135	Leonard Davis	do	D-1	1903	Driven, 1¼-inch	50		16	67		do	6.00		Domestic	
136	J. D. Addington	do	D-1	?1891	Bored, 4-inch	50	42	110	39		Hand, horse-power.			Domestic; stock	
137	D. W. Head	do	D-1	?1886		51			37		Hand			do	
138	Eugene Pohl	do	D-2		Bored, 4-inch	44	44	115	33		Artesian			Domestic	
139	A. Leatherman	do	D-2	1896	do	43	43	80	31		do			Stock	
140	T. J. Fowler	do	D-2	1900	Bored, 2-inch	43	43		32		do			Domestic	
141	do	do	D-2	1900	Bored, 4-inch	45	45		33	64	do			Stock	
142	Eugene Pohl	do	D-2		do	43	43	118	32	64	do			do	
143	W. M. Ward	do	C-2	1896	Hydraulic, 2-inch	42	42		35	64	do	100.00			
144	Geo. Covalt	do	C-2		Bored, 7-inch	42	42	103	35	65	do			Domestic; stock	
145	Alexander Strouthers.	do	C-2			42	42	123	35		do	81.35		do	
146	do	do	C-2		Bored, 7-inch	45	45	116	38		do			Irrigation; stock	
147	do	do	C-2		do	43	43	?116	40		do			Stock	
148	do	do	C-2		do	42	42	122	42	65	do			Domestic; irrigation.	7
149	N. Burwell	do	C-2	1899	Hydraulic, 2-inch	42	42	115	32	67	do	40.00		Domestic; stock	2
150	do	do	C-2	1900	Bored, 7-inch	42	42	115			do	115.00		Irrigation	
151	do	do	C-2		do	41	41	115	33		do	115.00		do	
152	do	do	C-2	1900	Hydraulic, 2-inch	42	42	115	32	67	do			Stock	
153	Silas Wright	do	C-2	1900	do	42	42	102	32	66	do			do	4

154	do	do	C-2		Bored, 4-inch	42	42	154	32	67	do			do	
155	J. W. McKeen	do	C-2	1894	Bored, 7-inch	42	42	76	33	67	do			Domestic; stock	
156	do	do	B, C-2	1898	do	42	42	128	32		do			Irrigation	7
157	do	do	C-2	1904	do	42	42	138	31	65	do	135.00		do	106
158	R. A. McKeen	do	C-2	1902	Hydraulic, 3-inch	42	42	76			do			Domestic; stock	
159	J. A. Ross	do	C-1	?1893	Bored, 4-inch	47	47	?80	33	62	do			Domestic	
160	T. D. Cheny	do	C-1	1890	do	47	47	112	29	64	do			Domestic; stock	
161	do	do	C-1	1901	Bored, 7-inch	50	50	154	32	66	do			Irrigation; stock	
162	C. W. Addington	do	D-1	1903	Hydraulic, 2-inch	51	51	?105	36	66	Hand	30.00		Domestic; stock	
163	W. L. Ross	do	C-1	1890	Hydraulic, 4-inch	47	47	?80	31	67	Artesian			Domestic	1
164	do	do	C-2	1902	Hydraulic, 2-inch	46	46	90+	33		do			Irrigation; stock	
165	H. L. Harding	do	C-2	1902	Bored, 4-inch	45	45	88	31		do	62.00		Domestic; stock	
166	C. Biedlback	do	C-2		Bored, 7-inch	43	43	101	32	66	do			Domestic; irrigation; stock.	7
168	A. M. Ward	do	C-2	1901	do	39	39	130	30		do	140.00		Irrigation	
169	do	do	C-2	1898	Hydraulic, 2-inch	37	37	90	30	66	do	30.00		Domestic	
170	Chas. Heil	do	C-2	1898		37	37	?90	27	70				Stock; irrigation	
171	do	do	C-2		Hydraulic, 2-inch	37	37	?90			Artesian			Stock	
172	do	do	C-2		Bored, 7-inch	38	38	119	32	66	do			Irrigation	
173	John L. Adams	do	B-2	1901	Hydraulic, 2-inch	37	37	128	30		do	74.00		do	
174	do	do	B-2	1896	do	33	33	72	30		do	19.00		Domestic	1
175	W. J. Adams	do	B-2	1896	Bored, 4-inch	35	35	88	32	68	do			Domestic; stock	15
176	H. Hazeltine	do	B-2		Bored, 7-inch	37	37				do			Irrigation; stock	7
177	do	do	B-2		Bored, 4-inch	37	37				do			do	
178	G. A. Walker	do	B-2	1903	do	35	35	100+	33	67	do			Domestic; stock	
179	do	do	B-2	1893	do	35	35		32	66	do			Stock	
180	Mrs. Gilbert	do	A, B-2	1903	do	34	34				do			Irrigation	
181	do	do	B-2		Hydraulic, 2-inch	35	35		32	66	do			Not used	
182	J. C. Nelson	do	B-1		Bored, 7-inch	38	38	111	32	66	do			Irrigation; stock	7
183	do	do	B-1		Bored, 4-inch	38	38		32		do			Domestic	
184	E. A. Chaffee	do	B-1	1885	do	40	40	96	32		do			Domestic; stock	
185	do	do	B-1	1885	do	38	38	100	33	66	do			Irrigation	4
186	do	do	B-1	1885	do	42	42	?100	33		do			do	4
187	do	do	B-1	1903	Hydraulic, 3-inch	41	41	113	32	67	do	60.00		Domestic	8
188	J. R. Fowler	do	B-1	1900	Bored, 4-inch	43	43	94	31	66	do	74.00		Domestic; irrigation.	

Wells in the Santa Ana quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
189	J. R. Fowler	Las Bolsas	B-1, 2	1901	Hydraulic, 3-inch	43	43	95	32	65	Artesian			Stock	
190	do	do	C-1	1901	do	45	45	118			do	$81.00		Irrigation	
191	Will Cheney	do	C-1	1900	Bored, 7-inch	47	47	?160	32		do	170.00		do	2
192	German-American Bank.	do	B-1		do	47	47	124	33	65	do			do	7
193	do	do	B-1		do	47	47				do			do	
194	Will Cheney	do	C-1	1900	Hydraulic, 3-inch	46	46	?80	32	65	do	13.20		do	18
195	Mrs. McFadden	do	C-2	1900	Hydraulic, 4-inch	45	45	?80	33	65	do	40.00		do	†17
196	Golden West Celery Co.	do	D-2		Bored, 7-inch	32	32		33	65	do			Domestic; irrigation.	
197	J. T. Worthy	do	B-2		Hydraulic, 2-inch	30	30		31	66	do			Domestic	
198	Oliver Stewart	do	A-2		Bored, 7-inch	32	32	112	32		do			Irrigation	
199	do	do	A-2	1903	Bored, 4-inch	32	32	110	33		do			do	
200	David Stewart	do	A-2		Hydraulic, 2-inch	29	29	110	37		do			do	
201	E. P. Justice	do	A-1	1884	Bored, 4-inch	35	35	114	32	65	do	90.00		Domestic; stock	
202	do	do	A-1	1897	do	35	35	114	32	65	do	90.00		do	1
203	do	do	A-1, 2	1894	do	32	32	96	32	65	do			Domestic; irrigation.	1
204	Mrs. Steltzer	do	A-1	1899	do	32	32	100	31	65	do			Domestic; stock	
205	M. F. McDonnell	do	A-1	1899	Bored, 7-inch	36	36	190	29	64	do	102.00		Domestic; irrigation; stock.	2
206	do	do	A-1	1890	Hydraulic, 2-inch	36	36	90	32	65	do			do	
207	Walker & Co	do	A-1		do	34	34		32	65	do			Stock	
208	do	do	A-1		Bored, 4-inch	[illegible]	[illegible]		[illegible]	[illegible]	do			do	

209	David Stewart	do	A-1		do	34	34	100	32	65	do			Domestic; stock		
211	J. P. Walker	do	A-1	1889	do	32	32	100	32	65	do			Domestic; irrigation; stock.		
212	Mary Mefford	do	A-1	1896	do	31	31	100+	31	65	do			Domestic; stock		
213	do	do	A-1	1900	Bored, 7-inch	30	30	100+	31	65	do			do		
214	Jas. McMillan	do	A-2	1885	Bored, 4-inch	29	29	86	32	65	do			do		
215	do	do	A-2	1894	do	30	30	100+	30		do			Stock		
216	Oliver Stewart	do	A-2		do	32	32	110	33	64	do			Domestic; stock		
217	David Stewart	do	A-2		do	32	32		31	64	do			do		
219	Golden West Celery Co	La Bolsa Chica	A-2	1888	Bored, 7-inch	26	26	100	31		do			Irrigation		
220	do	do	A-2		do	24	24	98	32		do			Domestic		
221	B. F. Townsend	do	A-2		do	24	24		23	63	do			Domestic; stock		
222	W. L. James	do	A-2	1899	do	26	26	96	32	64	do		100.00	do		29
223	do	do	A-2	1901	Bored, 6-inch	27	27		25		do		100.00	Irrigation		55
224	do	do	A-3	1904	Bored, 4-inch	27	27	69	32	64	do		45.00	do		8
227	B. F. Townsend	do	A-2		Hydraulic, 2-inch	22	22		30	64	do					4
228	do	do	A-2		Bored, 7-inch	22	22		24		do			Irrigation; stock		
229	do	do	A-2		do	22	22		31		do			Irrigation		
230	do	do	A-2		do	23	23		30		do			do		
231	do	do	A-2		do	24	24		31	63	do			do		
232	Southern Pacific R. R. Co.	do	A-2		do	22	22		31	64	Steam, artesian			Locomotives		
233	John Langdon	do	A-2		Hydraulic, 2-inch	20	20		29	63	Artesian			Domestic; stock		
234	do	do	A-2		Bored, 4-inch	20	20	75	25		do			Irrigation		18
235	do	do	A-3	1903	Bored, 6-inch	20	20	175	29	63	do			do		38
236	Mr. Stolp	Las Bolsas	A-3		Bored, 7-inch	22	22		28	64	do			Domestic; irrigation; stock.		
237	do	do	A-3		Bored, 4-inch	22	22		27	63	do			Irrigation		
238	do	do	A-3		do	21	21		22		do			do		
239	James Cain	La Bolsa Chica	A-3		Bored, 7-inch	25	25	300+	24	64	do			Domestic; stock		
240	do	Las Bolsas	A-3		Hydraulic, 2-inch	25	25		29	64	do			Stock		
241	M. F. McDonnell	do	A-3		Hydraulic, 1¼-inch.	25	25		28	63	do			do		
242	Eugene Pohl	do	A-3	1902	Hydraulic, 2-inch	24	24	171	35		do			Domestic; stock		
243	do	do	A-3		Bored, 4-inch	24	24	156	140		do			Irrigation; stock		
244	J. S. Collings	do	A-3	1891	Hydraulic, 2-inch	23	23	90	27		do			Domestic		

Wells in the Santa Ana quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
245	Mrs. A. Brush	Las Bolsas	A-2	1882	Bored, 4-inch	27	27	96	32	61	Artesian			Domestic; stock	
246	do	do	A-2	1899	Bored, 7-inch	27	27	300+	29		do			Irrigation	
247	Ocean View school district.	do	A-2		Bored, 4-inch	27	27		31	62	do			Domestic	
248	David Brush	do	A-2	1884	do	27	27	65	33	62	do			Stock	
249	Mr. Waddell	do	A-2		Hydraulic, 2-inch	27	27		31	62	do			do	
250	David Brush	do	A-2	1887	do	27	27		31	62	do			Domestic; stock	
251	do	do	A-2	1896	do	29	29		34	62	do			Stock	
252	do	La Bolsa Chica	A-2	1899	Bored, 4-inch	27	27		31	62	do			Irrigation	
253	John McFadden	do	A-2		do	27	27		31		do			Domestic; stock	
254	do	do	A-2		do	27	27		30	62	do			Stock	
255	Mr. Waddell	Las Bolsas	A-2		do	26	26		25		do			Domestic; stock	
256	S. C. Thompson	do	A-2	1902	do	23	23	789	27	61	do	$100.00+		Irrigation; stock	
257	do	do	A-2	1902	Hydraulic, 3-inch	24	24	789			do			Irrigation	
258	do	do	A-3	1903	Hydraulic, 2-inch	22	22	115	29		do	88.00		do	8
259	J. M. Hall	do	A-3	1899	Bored, 7-inch	22	22	150	28	60	do			Irrigation; stock	19
260	do	do	A-2	1900	Hydraulic, 2-inch	23	23	216	28	62	do			Irrigation	
261	do	do	A-2	1898		23	23	215	29		do	126.00		do	
262	V. F. Barnes	do	A-3	1901	Hydraulic, 2-inch	22	22	170+	29	61	do			Domestic; stock	
263	L. L. Stolp	do	A-3	1903	Hydraulic, 3-inch	23	23		27	60	do			do	
264	J. S. Collings	do	A-3	1904	Hydraulic, 4-inch	24	24	171	31		do	111.15		Irrigation	20
265	do	do	A-3	1901	Bored, 7-inch	25	25	186	30		do			do	
266	J. T. Stockton	do	A-3		Hydraulic, 2-inch	28	28		27		do			Domestic; stock	

267	.....do	.....do	A-3	1904	Bored, 7-inch	28	28	200+	27		.....do			Domestic; irrigation; stock.		
268	D. C. Tauts	.....do	A-3	1900	Hydraulic, 2-inch	32	32	225	28	63	.....do			.....do		
269	.....do	.....do	A-3	1899	Hydraulic, 3-inch	28	28	176	26		.....do			Irrigation		
270	Mr. Stewart	.....do	A-3	1904	Hydraulic, 2-inch	26	26	200+	28		.....do			Irrigation; stock.		4
271	J. Brush	.....do	A-3	1899	.....do	25	25	100+	28		.....do			Domestic; stock		
272	.....do	.....do	A-3	1892	.....do	23	23	100	29		.....do			Stock		5
273	.....do	.....do	A-3	1894	Bored, 4-inch	23	23	?140	28		.....do			.....do		
275	W. H. Young	.....do	B-2		.....do	24	24		30	62	.....do			Domestic; stock		
277	C. A. S. Howard	.....do	B-3		Bored, 7-inch	26	26	300+	26		.....do			Irrigation		
278	.....do	.....do	B-3		Bored, 4-inch	26	26	64	29	59	Not raised			Not used		
279	G. H. McGill	.....do	B-2	1897	Hydraulic, 2-inch	26	26	96	30	60	Artesian			Domestic		
280	.....do	.....do	B-2, 3	1892	Bored, 4-inch	26	26	100	42	62	.....do	85.00		Stock		
281	.....do	.....do	B-3	1892	.....do	27	27	118	29	61	.....do	85.00		Irrigation		
282	W. H. Young	.....do	B-2		Bored, 7-inch	27	27	115	32	62	.....do			Domestic; irrigation; stock.		7
283	Lewis Heil	.....do	B-2	1897	Bored, 4-inch	30	30	99	29	62	.....do			Domestic; stock		
284	.....do	.....do	B-2	1899	Bored, 7-inch	32	32	128	27	62	.....do	138.00		Irrigation; stock.		
285	.....do	.....do	B-2	1896	.....do	36	36	99	31	62	.....do	100.00		Irrigation		
286	.....do	.....do	B-3	1902	.....do	36	36	150	25	62	.....do			.....do		
287	W. H. Young	.....do	B-2		.....do	30	30		32	62	.....do			.....do		
288	Fred Heil	.....do	B-2	1903	Hydraulic, 2-inch	32	32		32	63	.....do			Stock		
289	.....do	.....do	B-2	1896	.....do	34	34	98	33	63	.....do			Domestic; stock		
290	.....do	.....do	B-2	1898	Hydraulic, 3-inch	33	33		29	63	.....do			Irrigation		
291	.....do	.....do	B-2	1900	Bored, 7-inch	33	33		31	62	.....do			.....do		
292	.....do	.....do	B-2	1900	.....do	34	34		31	62	.....do			.....do		
293	.....do	.....do	B-2	1900	.....do	35	35		30	63	.....do			.....do		
294	.....do	.....do	B-2	1898	Hydraulic, 2-inch	35	35	98	31	62	.....do			.....do		
295	.....do	.....do	B-2	1898	.....do	35	35	?100	29	62	.....do			.....do		4
296	Mr. Hemstock	.....do	B-3		.....do	36	36	100	31	63	.....do			Domestic		4
297	.....do	.....do	B-3		Bored, 4-inch	31	31		30	65	.....do			Irrigation		
298	M. C. Adams	.....do	B-3	1901	Hydraulic, 2-inch	29	29	100+	31	65	.....do			.....do		2
299	.....do	.....do	B-3	1900	.....do	30	30	100	28	64	.....do			Domestic; stock		
300	L. Decius	.....do	B-3		Bored, 7-inch	30	30	125	29	65	.....do			Irrigation		1
301	Robt. Elliot	.....do	B-3		Hydraulic, 2-inch	31	31		29	64	.....do			Domestic; stock		

Wells in the Santa Ana quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
302	Robt. Elliott	Las Bolsas	B-3		Bored, 7-inch	33	33		31	64	Artesian			Irrigation	
303	do	do	B-3		Hydraulic, 2-inch	33	33		36	66	do			do	
304	Jeff Leak	do	B-3		Bored, 7-inch	32	32	135	35	64	do			do	
305	G. L. Bayless	do	B-3		Hydraulic, 1¼-inch.	31	31		31	62	do			Domestic; stock	
306	Jeff Leak	do	B-3		Hydraulic, 2-inch	31	31		31	63	do			Irrigation	
307	Geo. Marcoyama	do	B-3		do	27	27	75	30	64	do			Domestic; stock	4
308	do	do	B-3		Bored, 3-inch	27	27	75	30	64	do			Irrigation	
309	D. C. Fauts	do	B-3	1901	Bored, 7-inch	30	30	200	27	64	do			Irrigation; stock	42
310	do	do	B-3	1900	Hydraulic, 3-inch	30	30	176	27	64	do			do	8
311	Mr. Fox	do	B-3		Bored, 7-inch	33	33		29	64	do			Irrigation	
312	C. A. Fowler	do	B-3		Hydraulic, 2-inch	33	33		29	65	do			Domestic; irrigation; stock.	
313	do	do	B-3		Hydraulic, 1¼-inch.	33	33		32	66	do			Irrigation	
314	do	do	B-3		Hydraulic, 2-inch	32	32		30	66	do			do	
315	Mrs. Williams	do	B-3	1897	Bored, 4-inch	34	34	140	31	65	do	$213.00		do	
316	J. C. McDowell	do	B-3	1902	Bored, 7-inch	33	33	144			do			do	95
317	Mr. Fox	do	B-3		Bored, 4-inch	32	32		30	64	do			do	
318	do	do	B-3		Bored, 7-inch	33	33		27	65	do			do	
319	J. C. McDowell	do	B-3	1899	Hydraulic, 2-inch	33	33	99	32	65	do			Domestic; stock	
320	C. W. Fox	do	B-3		Bored, 2-inch	35	35		31	65	do			do	
321	John L. Adams	do	B, C 3		Hydraulic, 3-inch	35	35	80	30	64	do			do	
322	do	do	C 3		Hydraulic, 2-inch	35	[illegible]		[illegible]		do			Irrigation; stock	

323	Mr. Fox	do	B-3	1898	Hydraulic, 3-inch	35	35	89	28	61	do			Irrigation	10
324	Mr. Raymond	do	B-3	1898	Bored, 3-inch	35	35	112	30	63	do			do	
325	James Heaston	do	C-3		Hydraulic, 2-inch	33	33		28	64	do			Domestic; stock	
326	James S. Heaston	do	C-3	1902	do	33	33		32	64	do	38.00		Irrigation	4
327	C. McDowell	do	C-3		Hydraulic, 1¼-inch.	33	33		28	63	do			Domestic; stock	
329	Silas Wright	do	C-2	1895	Bored, 7-inch	41	41	88	31	61	do	88.00		Irrigation; stock	19
330	do	do	C-2	1895	Hydraulic, 2-inch	40	40	80	30	63	do			Irrigation	
331	do	do	C-2	1895	do	41	41	103	32	63	do			Irrigation; stock	
332	do	do	C-2	1884	Bored, 4-inch	41	41	106	31	63	do	74.20		do	15
333	do	do	C-2	1879	Hydraulic, 4-inch	39	39	102	31	63	do			do	
334	Frank Beswick	do	C-2		Hydraulic, 2-inch	39	39		34		do			do	2
335	Silas Wright	do	C-2	1897	Bored, 7-inch	39	39	109	26	62	do	109.00		Irrigation	42
336	do	do	C-2	1895	Hydraulic, 2-inch	39	39	106	30	64	do	36.00		Irrigation; stock	
337	Lewis Heil	do	C-2	1896	do	38	38	94	32	64	do			do	4
338	R. R. McDowell	do	C-3	1898	Hydraulic, 3-inch	37	37	85	31	64	do			Domestic; stock	
339	James Lintott	do	C-3		Hydraulic, 2-inch	35	35		33	64	do			do	
340	do	do	C-3		do	35	35		32	64	do			Irrigation	
341	W. A. Jones	do	C-3	1903	Bored, 4-inch	36	36	97	31	65	do	75.00		Domestic; irrigation; stock.	
342	Mrs. M. F. Jepsen	do	C-3	1900	Hydraulic, 2-inch	37	37		26	65	do			do	
343	do	do	C-3	1900	Bored, 4-inch	37	37	94	31	65	do			Irrigation; stock	20
344	J. S. Rice	do	C-3	1884	do	38	38		31	64	do			Domestic; irrigation; stock.	
345	Robert Graham	do	D-3		do	39	39	96	32	65	do			do	4
346	M. B. Price	do	C-3	1884	do	40	40		31		do				
347	I. Harshlan	do	D-3	1899	Hydraulic, 2¼-inch.	37	37	76	32	65	do	35.00		Domestic; stock	6
348	do	do	C-3		Bored, 4-inch	37	37	100+	27	64	do			Irrigation	
349	S. H. Overacker	do	D-3	1902	do	37	37	101	34	65	do	70.00		do	14
350	do	do	D-3	1900	Hydraulic, 2-inch	36	36	96	33	64	do	41.00		do	
351	G. A. Winn	do	D-3	1903	Bored, 7-inch	39	39	97	35	64	do			Domestic; irrigation; stock.	12
352	do	do	D-3		Hydraulic, 4-inch	40	40	89	32	63	do			Irrigation	
353	Eugene Pohl	do	D-2		Bored, 4-inch	43	43	125	35	63	do			Domestic; irrigation; stock.	
354	do	do	D-2		do	42	42	120	30	64	do			Irrigation; stock	

Wells in the Santa Ana quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
355	Eugene Pohl	Las Bolsas	D-2		Bored, 4-inch	42	42	122	32	64	Artesian			Irrigation; stock	
356	Silas Wright	do	C-2	1895	Bored, 7-inch	40	40	102	33	65	do			do	
357	J. P. Jaques	do	D-2	1903	do	42	42	116	36	66	do	$160.00		Domestic; stock	
358	S. H. Overacker	do	D-2	1898	Bored, 4-inch	41	41	98	35	65	do	75.00		do	
359	Chas. O'Donnell	do	D-3	1903	Bored, 7-inch	40	40	101	34	67	do			Irrigation; stock	19
360	T. J. Williams	do	D-3	1888	Hydraulic, 4-inch	40	40	142	35		do	150.00		Stock	
361	do	do	D-3	1884	Bored, 6-inch	41	41	160	35	66	Not raised			Not used	
362	do	do	D-3	1884	Bored, 4-inch	40	40	140	35		Artesian, hand			Domestic; irrigation.	
363	H. A. Williams	do	D-3	1874	do	37	37	100	33		do			Domestic; stock	
364	do	do	D-3	1874	do	37	36	110	34	66	Horsepower		$160.00	Irrigation	30
365	do	do	D-3	1904	Bored, 7-inch	37	37	164			Gas	113.00	700.00	do	
366	John Smith	do	D-3	1899	Hydraulic, 2-inch	37	37	107	35	66	Artesian			Stock	Small.
367	Mr. Martin	do	E-3	1874	Hydraulic, 3-inch	38	38	115	38		do			do	Small.
369	Mr. Bates	do	D-3	1902	Hydraulic, 2-inch	35	35	116	33	65	do			Irrigation	4
370	do	do	D-3	1902		34	34		31		do			do	Small.
371	J. P. Jaques	do	D-3		Bored, 4-inch	36	36		33	64	do			Stock	Small.
372	M. T. Doig	do	D-2	1884	do	41	41	130	36	65	Wind			Domestic; stock	
373	do	do	D-2	1884	do	41	41	130			Artesian			Irrigation; stock	
374	W. A. Bedford	do	D-2		do	41			35	65	Hand				
375	J. E. Ann	do	D-2	1902	do	41	41	160	30	64	do	180.00		Domestic; stock	
376	F. Butts	do	E-2		do	42	42		38	62	do			do	
377	J. T. Smith	do	D-2	1899	Bored, 2-inch	43	41	130	36	61	do			do	

378	W. A. Bedford	do	E-2	1884	Bored, 4-inch	43	42	90			Not raised			Not used	
379	F. E. Anderson	do	D-2		do	43	43	112	35	63	Artesian			Irrigation	
381	E. L. Elliott	do	E-3	?1883	do	34	34	104	33	64	do			Domestic; stock	
382	Geo. Brown	do	E-2		Hydraulic, 1¼-inch.	34	34		30		do			Stock	
383	L. W. Weary	do	E-3, 4	?1884	Bored, 4-inch	34	24	104			Hand			Domestic; stock	
384	Jasper Botchard	do	D-3, 4		Hydraulic, 3-inch	34	34	116	31	64	Artesian			Irrigation; stock	8
385	do	do	D-3		Bored, 3-inch	34	34	104	31	64	do			do	
386	do	do	D-4		Hydraulic, 3-inch	34	34		32		do			do	12
387	S. J. Pankey	do	D-3		Bored, 4-inch	35	35	100+	35	63	do			Domestic; stock	
388	B. B. Miller	do	D-3	1904	Hydraulic, 1¼-inch.	36	36	96	33	63	do			do	
391	Caspar Borchard	do	D-4	?1902	Hydraulic, 2-inch	32	32	120	31	61	do			do	4
392	Von Suelts	do	E-4		Bored, 4-inch	32	32				do			Stock	
393	A. F. Hallstrom	do	E-4	1903	Bored, 7-inch	32	32	400	29		do			Domestic; stock	Small.
394	Mr. Hoskins	do	E-4	1903	Bored, 4-inch	33	33	340	25		Artesian, gas			Irrigation	Small.
395	do	do	E-4	1903	Bored, 6-inch	34	34	300+	28	68	do			do	Small.
396	John DeVenney	do	E-4	?1889	Bored, 7-inch	33		126	28	64	Artesian			Domestic; stock	
397	Mr. DeWitt	do	E-3		Bored, 4-inch	33	33	79	33	64	do			Irrigation; stock	Small.
398	Mr. Black	do	D-4		do	32	32	98	29	63	do			Stock	Small.
400	Frank Thompson	do	C-4	1900	Hydraulic, 1¼-inch.	33	33	82	32	63	do			Domestic; stock	
401	G. W. Brown	do	C-4	1898	Bored, 2-inch	35	35	100	31	64	do			Domestic; irrigation.	1
402	do	do	D-4	1900	do	34	34	125			do			Irrigation	1
403	Wm. Hammer	do	C-4		do	35	35	90	32	64	do			Stock	8
404	Mrs. Roberts	do	D-3		do	39	39		33	64	do			Irrigation; stock	
405	J. H. Hoff	do	C-3	1903	Bored, 4-inch	37	37	99	35	64	do			Irrigation	4
406	S. Breutlinger	do	C-3	1903	Bored, 2-inch	37	37	100			do			Domestic; stock	
407	G. A. Warner	do	C-3	1904	do	36	36	98	30	64	do			Domestic; irrigation.	2
408	N. D. Helms	do	C-3	1904	Bored, 3-inch	36	36	83	30	64	do			Irrigation	3
409	L. D. Rush	do	C-4	1900	Bored, 2-inch	33	33	90	32	64	do			Domestic; irrigation.	3
410	Dan Gerson	do	C-4	?1898	Bored, 4-inch	33	33	100	32	64	do			Irrigation	5
411	Oswald Kutzner	do	C-4	1900	Bored, 2-inch	30	30	96	32	64	do			do	4
412	B. G. Page	do	C-4	1904	do	30	30	102	33	64	do			Domestic	Small.

Wells in the Santa Ana quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
413	Geo. Dixon	Las Bolsas	D-4	1898	Bored, 2-inch	30	30	96	32	64	Artesian			Domestic; irrigation.	4
414	do	do	D-4	1898	do	31	31	96	32	64	do			Irrigation	4
415	O. H. Ellis	do	D-4	1903	do	29	29	96	32		do			Domestic; stock	2
416	do	do	D-5	1898	do	27	27	96			do			Stock	2
417	Wm. Dunn	do	C-4		Bored, 3¼-inch	31	31	98	33	64	do			Irrigation	
418	W. H. Sprouls	do	C-4	1901	Bored, 2-inch	32	32	90	31	64	do			Domestic; stock	
419	Mrs. M. Page	do	C-4	1904	do	32	32	90	33	64	do			Domestic; irrigation.	5
420	do	do	C-4	1900	do	33	33	93			do			Irrigation	4
422	L. A. Lindsay	do	C-4	1902	Bored, 3-inch	34	34	83	31	64	do			Domestic; stock	3
423	Mrs. Nimocks	do	C-4	?1896	Bored, 7-inch	35	35	84	32	64	Artesian, gas			Domestic	Small.
424	T. P. McWaters	do	C-4	1901	Bored, 2-inch	36	36	86			Artesian			Irrigation	2
425	Bowman Martin	do	C-4	1898	Bored, 3-inch	37	37	78	31	64	do			Irrigation; stock	11
426	John Walsh	do	C-4	?1885	Bored, 4-inch	36	36	70	29	64	do			Domestic; stock	
427	Bowman Martin	do	C-4		Bored, 2-inch	37	37				do			Irrigation	2
428	R. J. Cary	do	C-3		do	38	38	86	31		do			Domestic; stock	
430	Mr. Dundas	do	C-3		do	38	38		33	64	do			Irrigation; stock	Small.
431	do	do	C-3		do	37	37				do			Irrigation	2
432	J. R. Cary	do	C-3	1897	do	37	37	110	32	64	do			Domestic	3
433	do	do	C-3	1897	do	37	37	115			do			Stock	4
434	do	do	C-3		Bored, 7-inch	37	37	110			Not raised			Not used	
435	James Cox	do	C-4		Bored, 2-inch	36	36	79	31	63	do			Domestic; stock	1

436	Omie Ater	do	C-4	1901	do	35	35	90	33	64	do			do	
437	A. F. Swift	do	C-4	1903	do	34	34	96	29	65	Artesian			Domestic; irrigation.	4
438	Harry West	do	C-5	1900	do	33	33	75			do			Domestic; stock	
439	do	do	C-5	1899	Bored, 3-inch	33	33	80	28	64	do			Irrigation	2
442	Omie Ater	do	C-4	1900	Bored, 2-inch	37	37	90			do			do	4
443	W. F. Taylor	do	C-4	?1884	Bored, 7-inch	37	37	100	33	64	do			do	8
444	Talbert school district	do	B-4	1898	Bored, 2-inch	37	37	?100	31	64	do			Domestic	
445	J. H. Cox	do	C-4	1900	do	37	37	91	31	61	do			Irrigation	Small.
446	A. Martel	do	B-4	1898	do	37	37	100	32		do			Domestic; irrigation.	1
447	do	do	C-4	1897	do	37	37	100			do			Irrigation	
448	J. H. Cox	do	C-4	1903	do	37	37	90	31	64	do			do	2
449	R. B. Wardlow	do	B-4	1897	Bored, 4-inch	38	38	84	32	64	Artesian, wind			Domestic; stock	
450	do	do	B-4	1904	do	38	38	90			Artesian			Irrigation	2
451	do	do	B-4	?1894	Bored, 7-inch	38	38	96			Not raised			Not used	
452	do	do	B-3	1904	Bored, 4-inch	39	39	90	33	64	Artesian			Irrigation	Small.
453	do	do	B-4		Bored, 2-inch	38	38	86			do			Irrigation; stock	Small.
454	C. W. Fox	do	B-3			38	38	90	33	64	Hand			Domestic	
456	R. B. Wardlow	do	B-3	1898	Bored, 2-inch	39	39	100	31	64	Artesian, hand			do	
457	do	do	B-3	1902	do	40	40	90	32	63	Artesian			Irrigation; stock	2
458	A. McChristian	do	B-3	1899	do	39	39	106	32	63	do			Domestic; irrigation.	3
459	do	do	C-4	1902	do	38	38	93			do			Irrigation	3
460	do	do	C-3		do	38	38	86	31	64	do			do	1
461	do	do	C-3	1901	do	39	39	100	31	64	do			do	1
462	do	do	B, C-4	?1898	do	38	38	98	31	63	do			do	2
463	R. B. Wardlow	do	B-4	1904	do	37	37	90	30	64	do			Not used	Small.
464	do	do	C-4	1904	do	37	37	96			do			Stock	4
465	do	do	C-4	1898	do	37	37	92			do			Irrigation	3
466	do	do	C-4	1902	do	37	37	90	32	64	do			do	2
468	W. F. Taylor	do	C-4		do	37	37	93	32	65	do			Domestic; stock	1
469	Sam Talbert	do	B-4	1904	do	37	37	90	32	64	do			Domestic	4
470	do	do	B-4	1898	Bored, 4-inch	37	37	90	31	65	do			Domestic; stock	
471	do	do	B-4	1903	Bored, 7-inch	37	37	120	31	64	do			Irrigation	5

Wells in the Santa Ana quadrangle—Continued.

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						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
472	J. Alton	Las Bolsas	C-4		Bored, 4-inch	36	36		34	64	Artesian			Domestic; irrigation.	1
473	O. P. Wood	do	C-4	?1900	Bored, 2-inch	35	35		33	64	do			Domestic	
474	do	do	C-4	1901	do	34	34	90			do			Irrigation	
475	T. J. Lewis	do	B-4	1904	Bored, 7-inch	38	38	131	32	64	do			do	24
476	do	do	B-4	1903	do	38	38	120			do			do	9
477	do	do	B-4		Bored, 4-inch	36	36		32	64	do			do	5
478	John H. Pope	do	B-5	1898	Bored, 7-inch	35	35	120	30	65	do			Domestic; irrigation.	12
479	Geo. Edwards	do	C-5	1897	Bored, 2-inch	35	35	80	30	65	do			Domestic	1
480	Geo. Bradley	do	B, C-5		Bored, 7-inch	35	35		30	65	do			Domestic; irrigation.	7
481	T. V. Talbert	do	B-4, 5	1901	do	38	38	100	30	63	do			Irrigation	7
482	J. E. McGowen	do	B-4		Bored, 2-inch	40	40	97	31	63	do			Domestic; stock.	2
483	do	do	B-4	1904	Bored, 7-inch	40	40	130		63	do			Irrigation	14
484	R. Courreges	do	B-4	1900	do	45	45	210			do			do	12
485	L. Wells	do	B-3	1901	Bored, 4-inch	38	38	100	31	64	do			Domestic; irrigation.	8
489	R. Courreges	do	B-4	1897	Bored, 8-inch	50	33	148	31	65	Wind			Domestic; stock.	
490	do	do	B-4	1898	Bored, 7-inch	55	33	149			do			Stock	
491	A. J. Young	do	A-4	1903	Bored, 2-inch	35	35	288			Artesian			Irrigation	6
492	do	do	A-4	1903	do	35	35	258			do			Not used	
493	S. J. Strakes	do	A-4	1898	Bored, 3-inch	45		?100			Hand			Domestic	
494	H. H. Lewis	do	A-3, 4	1901	Bored, 7-inch	40	30	318			Artesian			Irrigation	6

495	C. S. Hoff	do	A-3	1900		30	30	300			do		do	
496	A. C. Shears	do	A-3	1896	Bored, 2-inch	35	23	153			Wind		Domestic; stock	
497	W. J. Horton	do	A-3	1902	Bored, 6-inch	30	30	?400			Artesian		Irrigation	11
498	A. A. Fisk	do	A-3		Bored, 2-inch	35		160			Hand		Domestic	
499	J. T. Stockton	do	A-3	1904	Bored, 10-inch	30	30	360			Artesian		Irrigation	
500	John Blalock	do	A-3		Bored, 7-inch	30	30	346+			do		do	6
501	S. W. Elliott	do	A-3	1897	Bored, 2-inch	33	33	162			do		do	4
502	do	do	A-3	1897	do	35	35	162			Hand		Domestic; stock	
503	do	do	A-3	1898	Bored, 3-inch	30	30	147			Artesian		Irrigation	
504	W. M. Fowler	do	A-3	1897	Bored, 2-inch	35	35	147			Siphoned		do	
505	do	do	A-3, 4	1897	do	40	35	149			Hand		Domestic; stock	
506	S. J. Strakes	do	A-3	1897	Bored, 3-inch	30	30	?100			Artesian		Irrigation	
508	A. C. Adams	do	A-4	1900	Bored, 7-inch	40	40	365			do		do	9
509	S. J. Strakes	do	A-4	1897	Bored, 4-inch	45	30	121			Hand		Domestic	
510	R. Courreges	do	B-4	1898	Bored, 2-inch	40	40	84	31	64	Artesian		Irrigation	1
511	T. V. Talbert	do	B-4		Bored, 7-inch	38	38	?120	37	64	do		do	
512	J. W. Fairchild	do	B-4	1902	Bored, 2-inch	38	38	90	31	64	do		Domestic	2
513	do	do	B-4	?1874	Bored, 7-inch	40	40	90			do		Irrigation	7
515	W. R. Fowler	do	B-4	?1900	do	37	37	115			do		do	4
516	R. O. Wells	do	B-4	1902	Bored, 2-inch	38	38	100	31	64	do		Domestic; stock	Small.
517	Sam Dungan	do	B-4		Bored, 3-inch	40	40	?100	31		do		Domestic; irrigation.	
518	W. R. Fowler	do	B-4	1903	Bored, 2-inch	38	38	75			do		Irrigation	4
519	C. F. Ward	do	B-4	1903	Bored, 7-inch	38	38	104			do		Domestic; irrigation,	22
520	do	do	B-4		do	38	38	108			do		Irrigation	17
525	Henry Talbert	do	B-5	1902	do	35	35	?120	32		do		do	16
526	Dan Rhodes	Santa Ana	F-1		Bored, 6-inch	73	63	?100	44		Wind		Domestic; stock	
527	Mr. Dearendoff	do	F-1	?1901	Driven, 1¼-inch	75	63		108		do		Irrigation	
527a	do	do	F-1	?1901	Bored, 7-inch	75	63	100			do		do	
528	Chinese Market Gardeners.	do	F-1		do	80	62	160	38		do		Domestic; stock	
529	J. S. Cardell	do	F-1	?1889	Bored, 4-inch	63	52	80	47		do		Domestic	
530	C. C. Rubottom	do	F-1		Bored, 3½-inch	60	48	60	37		do		Domestic; stock	
531	S. D. Butler	do	F-1	1888	Bored, 4-inch	65	54	83	46		do		Irrigation	
532	Henry Lucas	do	F-1	1887		60	51	100	44	65	Hand		Domestic	

Wells in the Santa Ana quadrangle—Continued.

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						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
533	Geo. Meganity	Santa Ana	F-1	1888	Bored, 4-inch	58	48	83	47	67	Hand			Domestic	
534	S. D. Butler	do	F-1	1888	do	58	47	126			Wind			Irrigation	
535	W. W. Wilmot	do	F-1		do	45		68			Hand			Not used	
536	Mrs. M. R. Baley	do	F-1		do	60	48	90	41		Wind			Domestic; irrigation.	
537	V. E. Pierson	do	F-1	1903	Bored, 10-inch	50	40	104	35	66	Gas			Irrigation	†68
538	do	do	F-1	?1894	Bored, 4-inch	58	49	68			Hand			Domestic	
539	do	do	F-1	?1884	do	48	37	80			Not raised			Not used	
540	S. Trivoli	do	F-1	1898		55	49		47	65	Wind			Stock	
543	E. C. Johnson	do	F-1	?1899	Bored, 4-inch	73	72	?56	51	66	do			Domestic; stock	
544	A. L. Carter	do	F-1	?1884	do	80			52		Hand			Domestic; irrigation.	
545	A. A. Arms	do	F-1	1897		85	81	?64	50	67	Wind			Domestic; stock	
546	Frank Talbert	do	F-1	1902	Bored, 7-inch	75	72	?50	47	66	do			Domestic; irrigation; stock.	
547	W. F. McClintock	do	F-1	1899	Bored, 4-inch	73	71	?60	52	64	Hand			Domestic; stock	
548	do	do	F-1		Bored, 6-inch	75	71	?60			Flows into reservoir.			Stock	
549	do	do	F-1		Bored, 4-inch	75	71	?60			do			do	
550	W. H. Bates	do	G-1		Bored, 7-inch	85	77	?80	51		Wind			Domestic; irrigation; stock.	
551	L. T. Oswald	do	G-1	1904	do	85	77	52	120		Hand	$52.00		do	
552	Samuel Ross	do	G-1	1903	Bored, 9½-inch ch	85	73	62			Gas	321.00	$1,200.00	Irrigation	†80
[illegible]	Robert McFadden	do	G-1		Bored, 7-inch	90	69	118	38		Wind			Domestic, stock	

554	Samuel Ross	do	G-1	1902	do	88	78	152			Not raised			Not used		
556	H. S. Pankey	do	G-1	1890	do	75		66	48		Wind					
557	do	do	G-1	1890	do	75	66	49	42		Hand			Domestic		
558	do	do	G-1	1901	do	75	57	65			Gas	200.00		Irrigation		
559	do	do	G-1	1901	Bored, 10-inch	75	57	65			do	200.00		do		†80
560	do	do	G-1	1902	do	75	57	65			do	200.00		do		
561	Santa Ana Gun Club	do	F-1		Bored, 4-inch	74	74		48		Artesian			Stock		
562	Mr. Towle	do	G-1			77			86		Hand			do		
563	L. Rees	do	G-1	1900	Bored, 6-inch	77	57	66	41		do			Domestic; stock		
564	do	do	G-1	1878	Bored, 7-inch	75	64	312			Not raised			Not used		
565	Garensy Estate	do	G-1		do	90		312			do			do		
566	Samuel Ross	do	G-1	1903	do	76	66	80+	50		Wind	100.00	150.00	Domestic; stock		
567	do	do	G-1	1884	do	76	66	80+			Hand			Not used		
568	do	do	G-1	1884	Bored, 6-inch	83	76	80+			Not raised			do		
569	Mr. Melvin	do	G-1	1900	Bored, 4-inch	77		100	49	64	Wind			Domestic; irrigation.		
570	Mrs. J. Hassheider	do	G-1		Bored, 7-inch	75	47	61	50	67	do			Domestic; stock		
571	Dan. Rhodes	do	G-1		do	95	65	104	44	67	do			do		
572	Mrs. Mary Hawley	do	G-1	1903	Bored, 4-inch	95		80	45	67	Hand	65.00		do		
573	J. T. Wilson	do	G-1		Bored, 7-inch	93			49		Hand, gas			do		
574	Geo. Wandsheer	do	G-1	?1894	do	100	82	51	44		Wind, hand			do		
575	Mr. Buhart	do	G-1	1903	Bored, 12-inch	103	86	62	62	67	Wind			do		
576	A. E. Bird	do	G-1	1902	Bored, 7-inch	103		?68	47		do	68.00	+13[5].00	Domestic; irrigation; stock.		
577	R. Best	do	G-1		do	103	80	53	55		do			do		
578	M. Erreca	do	G-1		do	101			49		do			Domestic; stock		
579	U. L. Wilhite	do	G-1	1884	do	115	90	65	44		Hand			do		
580	John Manthei	do	G-1		do	92		?85	54		Wind			do		
581	C. M. Young	do	G-1		Bored, 6-inch	120	95	55	90		do			Domestic; irrigation; stock.		
583	T. M. Turner	do	G-1	1890	Bored, 7-inch	115		55	56	67	do			Domestic; stock		
584	Theo. Oswald	do	G-1	1888	do	113	100	54	53	66	do		+335.00	do		
585	Mr. Shelton	do	G-1	1891	do	102	90	56	52		do	50.00	150.00			
586	V. R. Casey	do	G-1		do	100	81	55	51	66	do			Domestic; stock		
587	Wm. Houmsom	do	G-1		Bored, 4-inch	105			51	66	do		+120.00	Domestic; irrigation; stock.		

Wells in the Santa Ana quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
590	J. G. Bailey	Santa Ana	H-1	1876	Dug, 10 feet; bored, 7-inch, 301 feet	135		311	41		Wind			Domestic; stock	
591	Santa Ana Steam Laundry Company.	do	H-1	1901	Bored, 7-inch	132	96	?86	51		Steam		$600.00	Domestic	
592	Santa Ana city waterworks.	do	G, H-1	1899	Bored, 10-inch	100	78	350	42	67	do			do	
593	do	do	G-1	1893	Bored, 7-inch	100	78	350	45	67	do			do	
594	do	do	G-1	1903	Bored, 12-inch	100	78	350	34	67	do	$775.40		do	166
595	do	do	G-1	1903	do	100	78	387			do	775.40		do	
596	do	do	G-1	1901	do	102	80	351	43	67	do	950.00		do	
597	L. M. Edwards	do	G-1		Bored, 7-inch	100	79	60	46		Wind			Domestic; stock	
598	Robert Show	do	G-1			105			67		Hand			do	
599	Wm. Briggs	do	G-1		Bored, 7-inch	100			62		do			do	
600	P. White	do	G-1		do	98			52		Wind			do	
601	F. J. Heil	do	G-1	1902	do	85	60	72			Not raised	87.00		Not used	
602	do	do	G-1	1883	do	80		76	49		Wind			Domestic; stock	
603	W. A. Penrod	do	G-1	1899	do	85	74	48	50		Hand			do	
604	Mrs. M. Funk	do	G-1	1888	Bored, 6-inch	85	72	57	60		do			do	
605	Chas. Silkwood	do	G-1		Bored, 4-inch	85			52		do			do	
606	Mrs. S. A. Sexton	do	G-1		Bored, 7-inch	100	82	56	48		do			do	
607	F. M. Gist	do	H-1	1882	do	105	83	110	41	67	Wind			Stock	
608	N. Palmer	do	H-1	1875		125		300	42		do			Domestic; irrigation; stock.	

609	Mrs. L. Moye	do	H-1	1890	Bored, 7-inch	130	98	?53	55		do			Domestic; stock	
610	Mr. Clinton	do	H-1		do	130			66		do			do	
611	J. H. Bruner	do	H-1	1877	do	130	100	58			do			Not used	
612	S. T. Miller	do	H-1	1886		136		40	57		do			Domestic; stock	
613	Ahlers & East	do	I-1	1904	Bored, 10-inch	138	96	336	36	71	Steam	672.00		Domestic	
614	P. Blanco	do	I-1			130			62		Hand			do	
615	D. Halladay	do	H-1	1882	Bored, 7-inch, 150 feet; 6-inch, 145 feet.	130	99	295			Wind			Not used	
616	Mrs. M. K. Beckett	do	H-1	1888		130		?160	52		do			Domestic; stock	
617	W. S. Rose	do	I-1	1892		133	87	57	64		do			do	
618	B. F. Nimms	do	I-1	?1893	Bored, 7-inch	133	98	42	60		Hand			do	
619	V. Earhart	do	I-1	1899	do	120	101	36	83		Wind			do	
620	M. D. Halladay	do	H-1	1886	do	130	110	279	48		do			do	
621	R. J. Blee	do	H-1	1888	Bored, 9¼-inch	127	112	?325	46		do			Stock; domestic	
622	Robert Talbert	do	H-1	1888	Bored, 7-inch	125	100	52	57		do			Domestic	
623	F. E. Bangs	do	H-1	1901	do	120	100	120	48		do	150.00	150.00	Domestic; stock	
624	D. Halladay	do	H-1	1900	Bored, 10-inch	120	98	450			Not raised	800.00		Not used	
625	L. F. & A. S. Holbrook	do	H-1, 2		Bored, 6-inch	116	100	58	65		Wind			Domestic; stock	
626	D. V. Pritchard	do	I-2	1892	Bored, 7-inch	112	100	42	90		Hand			Domestic	
627	do	do	I-2	1900	do	115	100	105			Not raised			Not used	
628	Chas. Andres	do	H-2	?1876	do	100		40	74		Hand			Domestic; stock	
629	Mr. Burch	do	H-1, 2	1901	do	110	92	63	60		do			Not used	
630	H. A. Skiles	do	H-1, 2	1898	do	110	92	30	106		do	25.00		Domestic; stock	
631	L. B. Skiles	do	H-1	1898	do	110	92	30	106		Wind	25.00		Stock; domestic	
632	W. H. Conder	do	H-1	1900	do	110		?100	49		do			Domestic; stock	
633	E. G. Huntington	do	H-1		Bored, 6-inch	110	93	60	48	68	do		40.00	do	
634	W. H. Ivans	do	H-2	?1886	Bored, 7-inch	105		?60	61		Hand			do	
635	Stephen Ross	do	H-2	1894	Bored, 6-inch	100	98	368	32		Wind			do	
636	Mr. Lancaster	do	H-2		Bored, 7-inch	98			36		Hand			do	
637	Mr. Lewis	do	G, H-2		Dug, 4 by 4 foot	85	75	12			Wind			Stock	
638	J. L. Barger	do	G-2		Bored, 4-inch	85	83	?270	42		Hand			Domestic; stock	
639	do	do	G-2		Bored, 7-inch	85	76	83			Not raised			Not used	
640	Chas. Anderson	do	G-2	?1894	Bored, 6-inch	80	71	60	35		Wind		+119.00	Domestic; stock	
641	A. C. Stanley	do	G-2	1902	Bored, 7-inch	87		91			do	91.00	40.00	do	
642	Mrs. Brown	do	G-1		do	87	79	115	39		Hand			Stock	

Wells in the Santa Ana quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
643	Morse & Randal	Santa Ana	G-1	1902	Bored, 7-inch	88	77	340	37		Hand	$488.37		Stock	
644	do	do	G-1	1904	Bored, 12-inch	88	77	270			Not raised	321.00		Not used	
645	J. A. Buckingham	do	G-1	?1875	Bored, 7-inch	95	80	39	57	68	Wind			Domestic; stock	
646	Frank Clapp	do	H-1	1890	do	100	82	38	56		Hand			Domestic	
647	James McFadden	do	H-2	1889	do	95	85	260	29		Wind			Domestic; stock	
648	do	do	H-2	1904	Bored, 10-inch	95	85	270			Installing pumping plant.				
649	do	do	H-2	1902	do	95	85	270			do				
650	do	do	H-2	1892	Bored, 7-inch	80	80	250	34		Artesian			Stock	
651	do	do	H-3	1870	Bored, 4-inch	58	58	50	42	69	do			Domestic; stock	
652	do	do	H-3	1901	Bored, 7-inch	58	58	400+	42	70	do			do	
653	do	do	H-3	?1901	Hydraulic, 2-inch	58	58	264	37	71	do				
654	do	do	G-3	1899	Bored, 7-inch	53	53	260	37	70	do			Irrigation	29
655	do	do	G-3	1899	do	51	51	260			do			Irrigation; stock	8
656	do	do	H-3		Bored, 10-inch	65	65	64	49	64	do			Stock	
657	W. W. Fisher	do	H-3			60	60	260+	42	68	do			Irrigation	
658	Delhi school district	do	H-3	1903	Hydraulic, 2-inch	62	62	224	44	68	do	91.00		Domestic	
659	James McFadden	do	G-4	1899	Bored, 7-inch	42	42	360			do			Stock	
660	do	do	H-3	1888	do	48	48	80	48	66	do			do	Small.
661	do	do	H-4	1888	do	41	44	60			do			do	
662	do	do	G-5	1904	Bored, 4-inch	48	48		44	70	do			do	

														tion; stock.	
664	J. D. Carter	do	H-2	1898		72	54	21	57		Hand			Domestic; stock	
665	L. H. Price	do	H-3	1896	Bored, 7-inch	68	62	380+	44		Gas			do	
666	do	do	H-3	1888	Bored, 4-inch	65	65	380+	40		Artesian			Irrigation	†27
667	C. E. Buell	do	H-3		Hydraulic, 2-inch	68	68	?260	41	70	do			Domestic; irrigation; stock.	
668	do	do	H-3		Hydraulic, 3-inch	67	67	260+	41		do			Irrigation	17
669	G. W. Stuart	do	H-3	1902	Bored, 7-inch	65	65	63	44		Hand	63.00		Domestic; stock	
670	do	do	H-3	1903	Bored, 3-inch	65	65	265	43	70	Artesian			Domestic; irrigation; stock.	5
673	Mr. Russell	do	H-3	1900	Hydraulic, 2-inch	58	58	263	42		do			Domestic; stock	
674	W. W. Fisher	do	H-3		do	58	58	260+	41	69	do			Domestic	
675	do	do	H-3		do	55	55	27	49	68	do			Stock	Small.
676	W. L. Neill	do	H-3		Bored, 7-inch	55	55	27	49	68	do			do	
677	Delhi school district	do	H-3		Bored, 4-inch	62	62				do			Not used	
678	Henry Meason	do	H-3	?1884	Bored, 5-inch	63	63		40	68	do			Domestic; stock	
679	do	do	H-3	1899	Hydraulic, 2-inch	62	62	180	34	68	do			do	
680	do	do	H-3	1898	do	60	60	?180			do				
681	Alfred Williams	do	I-3		Bored, 7-inch	64	64	200			do			Not used	
682	do	do	I-3		do	64	64	196	37	69	do			Irrigation	
683	O. B. and C. C. Bridgeford.	do	I-3	1892	Bored, 4-inch	65	63	53	51		Hand			Domestic; stock	
684	J. L. Allen	do	H-3		Bored, 5-inch	58	58	?200	39		Artesian			Stock	Small.
685	do	do	H-3			54	50	?150	44		Hand			Domestic; stock	
686	L. W. Allen	do	H-3	1904	Hydraulic, 3-inch	57	57				Artesian			Irrigation	
687	G. Mall	do	I-3	1903	Hydraulic, 2-inch	54	54	?210	37	70	do	85.00		Domestic; irrigation; stock.	
688	J. W. Robertson	do	I-3	1904	Bored, 2-inch	55	55	212	38	70	do	85.00		Domestic; stock	
689	J. P. Manning	do	H-4	1900	Bored, 4-inch	50	50	206+	40	72	do			do	
690	G. W. Gynn	do	H-3	1897	do	53	53	?209	38	71	do			Stock	
691	do	do	H-3	1901	Hydraulic 3-inch	53	53	212	40		do	100.00		Domestic; stock	3
692	do	do	H-3	1902	Bored, 7-inch	53	53	220	41	73	do	250.00		Irrigation	7
693	J. R. McCarter	do	H-3		Hydraulic, 2-inch	54	54	200+	43	72	do			do	
694	J. J. Ryan	do	H-3	1903	Driven, 2-inch	53	53	239			do			do	
695	do	do	H-3		Bored, 4-inch	57	57	40	52	72	Hand			Domestic; stock	
696	G. Mall	do	H-3	1904	Hydraulic, 2-inch	53	53	239	42		Artesian	127.00		Irrigation	5

Wells in the Santa Ana quadrangle—Continued.

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						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
698	Mr. Feathero	Santa Ana	H-4		Bored, 7-inch	48	48		45	67	Artesian			Stock	
699	C. A. Leighton	do	H-4		Hydraulic, 2-inch	52	52	200+	42	69	do			Irrigation	4
701	do	do	H-4		do	45	45	35	50		do			Domestic; stock	
702	Mr. Quick	do	H-4	1900	Bored, 7-inch	50	50	214	44	69	do			Irrrigation	
703	D. Boyd	do	H-4	1904	Hydraulic, 3-inch	45	45	196	41	70	do	$108.00		do	11
704	do	do	H-4	1897	Hydraulic, 2 inch	45	45	194	34	72	do	105.00		Irrigation; stock	3
705	do	do	H-4	1886	Bored, 4-inch	43	43	132	42	68	do			Domestic	
706	F. N. Morse	do	I-4		Hydraulic, 4-inch	53	53	218	41	70	do			Domestic; stock	4
707	do	do	I-3	1904	Bored, 10-inch	44	44	490	39	73	do	1,055.00		Irrigation	10
708	J. S. Fox	do	I-3	1878	Bored, 5-inch	60	60	?200	36	71	do			Domestic; irrigation; stock.	3
709	Mrs. Huntzinger	do	I-3	1884	Bored, 3-inch, inside of 7-inch.	65	65		37	68	do			Domestic; stock	
710	Chas. H. Wilbur	do	I-3	1908	Hydraulic, 2-inch	70	70	264	33	71	do	150.00		Domestic; irrigation; stock.	2
711	do	do	I-3	1899	Bored, 7-inch	75	75	331			do	400.00		Irrigation	4
712	W. S. Hall	do	I-3	1903	Hydraulic, 3-inch	73	73	250	38	68	do			Domestic; stock	2
713	do	do	I-3	1887	Bored, 7-inch	73	70	34	46	67	Hand			Not used	
714	Frank Thomas	do	I-3	1890	Bored, 4-inch	79	79	196	38	70	Artesian			Domestic; stock	4
715	J. S. Ellis	do	I-3	1904	Bored, 10-inch	67	67	284	37	70	do	500.00		Irrigation	
716	do	do	I-3	1876	Bored, 4-inch, inside of 7-inch.	67	67	250	37		do			Stock	
717	do	do	I-3	1900	Hydraulic, 3-inch	67	67	299	40		do	130.00		Domestic; stock	
718	Irvine Ranchio Co.	do	I-3	1904	Hydraulic, 2-inch	67	67	319	43	71	do				4

720	.....do	.....do	I-2	1892	Bored, 7-inch	85	85	185	38	71	Gas			Irrigation	42
721	Alton Warner	.....do	I-2		Hydraulic, 3-inch	85	83		42		Wind, horse-power.			Stock	
722	T. F. Brooks	.....do	I-2			90			54		Hand			Domestic	
723	J. C. Thomas	.....do	I-2	1902	Bored, 7-inch	98	93	200+			Not raised			Not used	
724	T. J. McCarter	.....do	I-2	1902	.....do	105		90+	51		Wind			Domestic; stock	
725	W. S. Ritchey	.....do	I-1	1870		110	98	200+	44		.....do			.....do	
726	B. S. Kerns	.....do	G-1		Bored, 6-inch	75	64	59	44		.....do			.....do	
727	Mathews & Travis	.....do	G-1	?1887	Bored, 7-inch	80	69	18	51		.....do			.....do	
728	P. M. Conkle	.....do	G-1	1903	Bored, 10-inch	76		98	48		Wind, hand			.....do	
729	T. P. Page	.....do	G-1	1903	Bored, 7-inch	76	68	69	51		Wind	72.00	+$295.00	.....do	
730	T. McPearson	.....do	G-1	1903	.....do	71	66	71	49		Hand			.....do	
731	J. S. Kohler	.....do	G-1		.....do	72	64	59	52		.....do			.....do	
732	B. W. Walker	.....do	G-1	1900	.....do	75	61	375	160		Gas	600.00	950.00	Irrigation	†40
733	C. A. Barton	.....do	G-1	1886		74		?85	46		Wind	80.00		Domestic; stock	
734	J. H. Parsons	.....do	G-2	1902	Bored, 7-inch	73		87	55	68	.....do			.....do	
735	Walter L. Neill	.....do	G-2		Bored, 4-inch	68	62	152	48	68	Hand			Stock	
736	.....do	.....do	G-2		Bored, 7-inch	68	65	64	54		.....do			Domestic; stock	
737	Fair Association	.....do	G-2		.....do	70			37		Wind			Roads	
738	R. J. Blee	.....do	G-2	?1900	.....do	75	75	355			Artesian	527.00		Stock	†35
739	Fair Association	.....do	G-2		.....do	64			43	68	Wind			Roads	
740	Mrs. S. E. Blake	.....do	G-2	?1898	.....do	63	63	?390	43	70	Artesian			Irrigation	
741	.....do	.....do	G-2	1897	.....do	62	62	95	40		Wind			Domestic; stock	
742	G. W. Bissett	.....do	G-2	?1884	Bored, 5-inch	63	63	?72	33	69	Artesian			Domestic; irrigation.	
743	.....do	.....do	G-2	?1884	Bored, 4-inch	65	65	?62	41	68	.....do			Domestic; stock	
744	B. W. Walker	.....do	G-2	1904	Bored, 9¼-inch (2)	70	69	114	41		Gas	800.00		Irrigation	
745	.....do	.....do	G-2		Bored, 4-inch	70	70		48	67	Hand			Domestic: stock	
746	C. C. Edingeir	.....do	G-2		.....do	73	72	54	52		.....do			Domestic	
747	.....do	.....do	G-2			74	74	56	47		Hand, artesian			Stock	
748	David Fickas	.....do	G-2		Dug, 5 by 5 foot	66	64	3	48	66	Hand				
749	G. H. Judd	.....do	G-2	1884	Bored, 4-inch	60	60	?130	48	68	Artesian			Domestic; stock	
750	.....do	.....do	G-2	1888	Bored, 4-inch, inside of 9-inch.	60	60	91	46	68	.....do			Domestic; irrigation.	
751	W. C. Ten Eyck	.....do	G-2	1898	Bored, 4-inch	57	57	96	48	68	.....do			.....do	

Wells in the Santa Ana quadrangle—Continued.

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						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
752	W. C. Ten Eyck	Santa Ana	G-2	1892	Bored, 5-inch	57	57	75	44	67	Artesian			Domestic; stock	
753	P. Stefanazzi	do	G-2	1879	Bored, 4-inch	56	56	67	42	67	do			do	
754	J. F. Cavanaugh	do	G-2	1881	do	55	55	55	46	66	do			do	
755	do	do	G-2	1892	do	53	53	69	43		do			Stock	4
756	do	do	G-2	1902	Hydraulic, 2-inch	53	53	75	44	66	do	$40.00		Irrigation	Small.
757	Joe Nusbaumer	do	G-2	?1892	Bored, 4-inch	58	58	?88	42		Wind	75.00		Domestic; stock	
758	do	do	G-2	1890	Bored, 7-inch	60	60	90+			Artesian			Irrigation	
759	do	do	G-2	1902	Hydraulic, 3-inch	61	61	?336	33	67	do	240.00		do	5
760	W. C. Long	do	G-2	1876	Hydraulic, 3¼-inch.	56	56	75	46	65	do			Domestic	
761	do	do	G-2	1902	Bored, 4-inch	55	55	377	29	65	do	275.00		Irrigation; stock	
762	do	do	G-2	1898	do	55	55	102	44	66	do			Irrigation	
763	do	do	G-2	1884	Bored, 2-inch, inside of 4-inch.	56	56	75	40	65	do			do	
764	do	do	G-2	1879	Bored, 4-inch	58	58	?150	43		do			do	
765	do	do	G-2	1886	Bored, 2-inch, inside of 4-inch.	58	58	114	47		do			do	
766	T. W. Clark	do	F-2		Bored, 4-inch, inside of 7-inch.	53	53		54	67	do			do	
767	F. W. Clark	do	F-2		Bored, 7-inch	50	50	?110	51	63	do			do	
768	J. W. Harmon	do	F-2	1879	Bored, 4-inch, inside of 7-inch.	53	53	98	37		Hand			Domestic; stock	
769	do	do	F-2	1879	Bored, 4-inch	52	52	85	41		do			Stock	
770	do	do	F-2	1878	Hydraulic, 2-inch	56	55	61	49	68	Artesian			do	

771	do	do	F-2	1904	Bored, 9½-inch	52	52	95			Gas			Irrigation	
772	do	do	F-2	1878	Bored, 6-inch	52	52	78			do			do	
773	do	do	F-2	1878	Bored, 10-inch	52	52	78			do			do	
774	do	do	F-2		Bored, 6-inch	50	48	190			Hand			Not used	
775	J. T. Raitt	do	F-2		Bored, 7-inch	48	42	201			Not raised			do	
776	do	do	F-1	1904	Bored, 10-inch	52	50	110	40		Steam			Domestic; stock	
777	do	do	F-1	1900	do	52	50	113	40		do			do	
778	do	do	F-1		Bored, 7-inch, inside of 10-inch.	52	50	98	40		do			do	
779	do	do	F-1	1901	Bored, 10-inch	52	50	110	40		do			do	
780	J. A. Timmons	do	F-1	1888	Bored, 4-inch	58	54	110	37		Hand			Domestic	
781	do	do	F-1	1901	Bored, 9-inch	61	59	112			Not raised			Not used	
782	do	do	F-1	1901	Hydraulic, 2-inch	62	60	112			do			do	
783	Joseph Thacker	do	F-1		Bored, 10-inch	55			42		Hand			Domestic; stock	
784	David McCarty	do	F-1		Bored, 4-inch	57			48		do			do	
785	Oliver Litten	do	F-1	1887	Bored, 6-inch	60		?110	36	69	do			do	
786	do	do	F-1	?1883	Bored, 7-inch	60	57	?110	43	66	Wind			Stock	
787	Geo. M. Stanton	do	F-1	?1883	Bored, 6-inch	55	49	350	37		do			Irrigation; stock	
788	do	do	F-1	?1883	Bored, 4-inch	57	57	75+	37		Hand			Domestic	
789	M. A. Simco	do	F-1	1891	do	57	55	?95	42	66	Wind			Domestic; stock	
790	V. H. Duncan	do	F-2		do	50	50	80	43	65	Artesian			do	
791	do	do	F-2		Hydraulic, 2-inch	48	48	69	41	65	do			Stock	1
792	do	do	F-2		Hydraulic, 1½-inch.	51	51		38		do			do	
793	R. M. Dungan	do	F-2		Bored, 4-inch	46	45	138	38		Hand			Domestic; stock	
794	do	do	F-3		Bored, 6-inch	47	47	85	39		Artesian			Stock	
795	Mr. Boland	do	E-2	1874	do	47	47	?450	31	66	do			Domestic; stock	35
796	V. H. Duncan	do	F-2		Bored, 4-inch, inside of 6-inch.	45	43	56			Not raised			Not used	
797	S. P. Boland	do	F-2	1882	Bored, 4-inch	40	40	90	37	65	Artesian			Domestic	
798	do	do	F-2	1902	Bored, 7-inch	48	43	116	39	65	do			Irrigation	4
799	do	do	F-2	1878	Bored, 2-inch, inside of 4-inch.	43	43	94	38	65	do			do	
800	J. W. Harmon	do	F-2			55	52	95	35						
801	Elmer Lipton	do	F-2		Bored, 7-inch	52	52	61	47	69	Artesian			Domestic; stock	
802	Mrs. McCarmack	do	F-2		Bored, 2-inch	52	52				do			Domestic	

Wells in the Santa Ana quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
858	J. L. Pinney	Santa Ana	F-3	1904	Bored, 10-inch	37	37	106	34	65	Artesian			Irrigation	
860	J. H. Sanders	do	E-4		Bored, 2-inch, inside of 7-inch.	35	35	?300	37	67	do			Domestic; stock	1
861	J. L. Pinney	do	E-3	?1884	Bored, 4-inch, inside of 7-inch.	36	36	64	34	67	do			Stock	
862	do	do	E-3		Bored, 4-inch	34	34	102	35	66	do			Irrigation	
863	do	do	E-3	1903	do	34	34	187			do			Stock	
864	Mr. Selvidge	do	E-3		do	37	37	96	38	65	do			do	Small.
866	E. C. Martin	do	I-1			125			49		Wind			Domestic; stock	
867	A. O. Birch	do	I-1	1899	Bored, 7-inch	182	112	?45	91		do	$45.00	$50.00	do	
868	P. Allen	do	I-1		Bored, 6-inch	121	91		52		do			Domestic	
869	J. P. Pope	do	I-1		Bored, 7-inch	117	97		151		do			do	
870	Winslow & Decker	do	I-2		do	114	96	52	62		do			do	
871	C. B. Bridgeford	do	I-2	1884	do	100		297	38		do			Domestic; stock	
872	John Cubber	do	I-2		do	107	88	50	68		do			do	
873	A. Fuller	do	I-2	1899	Bored, 10-inch, reduced to 6-inch.	107		360+	71		Gas			Irrigation	†50
874	do	do	I-2	1899	Bored, 6-inch	107		180			Wind			Domestic	
875	W. G. Smith	do	I-2	1878	Bored, 4-inch	110	84	?56	37	66	Hand			Domestic; stock	
876	W. Williams	do	I-2	1876	Bored, 5-inch	113	93	?220	46	67	Wind			do	
877	A. C. Williams	do	I, J-2		Bored, 7-inch	113	90	76	52		Hand			Stock	
878	O. H. Burke	do	I-1		do	118	98	?40	74	66	Wind		270.00	Domestic; stock	
879	C. P. Rice	do	I-1	?1876	do	121		90	52		do			Domestic	

881	T. F. Lee	do	I-1	1898	do	128	94	51	86	66	do		65.00	do	
882	Mrs. A. A. Twombly	do	I-1	?1883		128		?50	85	67	Hand			Domestic; stock	
883	J. S. House	do	I-1		Bored, 7-inch	128	103	?55	70		Wind			do	
885	W. H. Clary	do	I-1	?1897	do	132	95	?65	73		do			Domestic	
886	M. A. Menges	do	I-1	?1880	do	132	94	49	98		do			Domestic; stock	
887	Mrs. H. J. Winslow	do	I-1	?1884	Bored, 6-inch	127	103	52	70		do		133.00	do	
888	J. C. Metzgar	do	I-1		Bored, 6-inch, inside of 7-inch.	125	97	56	68		do			do	
889	F. P. Fraser	do	I-1	1902	Bored, 7-inch	125	95	?42	74		Hand	45.00		Domestic	
890	J. F. Schlange	do	I-1		Bored, 6-inch	126	102	28	201		Wind			do	
891	A. McFadden	do	I-1	?1885	Bored, 7-inch	121		60+	59		do			do	
892	W. P. Brown	do	I-1	1901	do	120	100	42	60		do			do	
895	J. S. Leck	do	J-2		do	113	83	?90	37		Hand			Domestic; stock	
896	Mrs. M. Richey	do	J-2	1882	do	110	98	90	68	65	Wind			Domestic	
897	do	do	J-2	?1889	do	110	93	183			Not raised			Not used	
898	Santa Fe R. R. Co	do	J-2		Bored, 8-inch	90	83		55		Hand			Domestic	
899	E. L. Bouman	do	J-2	1901	Bored, 7-inch	104	91	67	140		do			Domestic; stock	
900	F. W. Harding	do	J-2			102			190		Wind			do	
902	T. J. Crawford	do	J-2	1889	Bored, 4-inch	100		?66	82		Hand			Domestic	
903	L. A. Cock	do	J-2	1884	Bored, 7-inch	75	64	?96	52		do			Domestic; stock	
904	P. Ramon	do	J-3	1880	Bored, 4-inch	66	66	120+	52		do			do	
905	E. M. Wheeler	do	K-2	1889		70		45	63						
906	do	do	K-2	1904	Bored, 7-inch	70	64	80	33		Gas	76.80		Stock	†20
907	Irvine Rancho Co	San Joaquin	K-2		Hydraulic, 2-inch	65	65	200	53	68	Artesian			do	
908	S. P. Bowland	Santa Ana	K-2		Bored, 7-inch	85			73	65	Wind			Domestic; stock	
909	W. G. Mitchell	do	K-2	1902		103		96	63		do			do	
911	E. M. Neally	do	J-2		Bored, 7-inch	114			48	66	do			Domestic	
912	S. Stevens	do	J-2		do	115			65		Hand			do	
913	J. B. Bowman	do	J-2		do	113		30+	124		do			do	
914	E. H. Stanley	do	J-2	1897	Hydraulic, 2-inch	113	106	280+			Wind			Domestic; stock	
915	C. C. Cozzad	do	J-2	?1884		112		?100	107		Wind, hand			do	
916	Louis Ebel	do	J-2			112		?140			Hand			Domestic; irrigation.	
917	G. G. Godfrey	do	J-2	1879	Bored, 7-inch	112	100	?250	36		do			Domestic	
918	E. M. Crellin	do	J-2	?1895	do	115	88	166	42		Wind			Domestic; stock	

Wells in the Santa Ana quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
919	W. C. Crawford	Santa Ana	J-2	1888	Bored, 7-inch	116		?69	78		Wind			Domestic	
921	P. T. Adams	do	J-1		do	120			56		do			Domestic; stock	
922	I. L. Marchant	do	J-1	?1889	do	125		?130	57		do			Domestic	
923	H. A. Allen	do	J-1			128	95	86			do			Domestic; stock	
924	F. E. Monahan	do	I-1	1884	do	133	97	52			do			do	
925	Mrs. M. L. Adams	do	I-1	?1888	do	133			70		do			do	
926	J. M. Raugh	do	I-1	?1889	do	133		?90	81		do		$140.00	do	
928	Mrs. A. C. Gulick	do	J-1	?1880	do	133	93	47	72		do			do	
929	L. F. Sheets	do	J-1	1879	Bored, 4-inch	133	90	300+	56		do			do	
930	Geo. Liggett	do	J-1		Bored, 7-inch	130		?80	75		Hand			do	
931	L. Hillyard	do	J-1	?1892	do	130	100	?60	77		Wind			do	
932	Mrs. S. E. Wilcox	do	J-1	1880	do	130		?80			do			do	
933	V. V. Tubbs	do	J-1	?1873	do	140		75	54		Wind, gas			do	
934	do	do	J-1	1902	do	140	87	202			Not raised			Not used	
935	H. Diers	do	J-1		do	133	81	56	115		Wind			Domestic; stock	
936	Henry Leck	do	J-1	?1880	do	132	112	?100	62		do			Domestic	
937	J. T. Morehead	do	J-1	1894	do	132	92	108	59		do	$63.00	170.00	Domestic; stock	
938	M. E. Phillips	do	J-1	1890	do	134	94	70	87		Hand			Not used	
939	C. B. Leddick	do	J-1		do	137			59		Wind			Domestic; stock	
940	C. W. Bowers	do	K-1	1886	do	132	79	?67	60		do			do	
941	J. S. Rice	do	K-1		Hydraulic, 3-inch	135			61	66	do			do	
942	James Smith	do	K-1		Bored, 7-inch	128			48		Hand			do	
943	F. Chast	do	K-1	1891	Hydraulic, 3-inch	131	91	50	48		Wind			do	

945	A. L. Paul	do	K-1	1902	Dug, 3 by 3 foot	135	85	100+	50		do			Domestic; stock	
947	Mrs. M. J. Clifford	do	K-1	1886	Bored, 7-inch	127		61	57		do				
948	E. L. Bouman	do	K-1		Dug, 3 by 3 foot; bored, 7-inch.	128		?120	45		do			Domestic; stock	
949	Mr. Ross	do	K-1		Bored, 7-inch	128	78	?120	58		Wind			do	
950	John Taylor	do	K-1	1884	Dug, 4 by 4 foot	125	78	50	53		Hand			do	
951	C. M. Halderman	do	K-1		Bored, 6-inch	133	87	77			Not raised			Not used	
952	do	do	K-1		Bored, 7-inch	132			46		Wind			Domestic; stock	
953	G. W. Diffenderfer	do	J-1	1895		130		80	60		do			do	
954	David Hewes	do	J-1		Bored, 7-inch	128	89	115	57		do			Domestic	
956	C. E. Utt	do	J-1	1897	Bored, 10¼-inch	127	102	450	52		Gas			do	10
958	J. O. Pebele	do	J, K-1	1885	Dug, bored, 7-inch	127	97	57	57		Wind	97.00		do	
959	Irvine Rancho Co	Lomas De Santiago.	M-3	?1876	Bored, 7-inch	135	96	300+	131		do			Stock	
960	do	do	M-2	?1877	do	135	127	?400	59	68	do			Domestic	
961	do	San Joaquin	L-2	1897	do	74	72	?350			Not raised			Not used	
962	do	Santa Ana	I-4	1878	do	47	47	?200	41	70	Artesian			Irrigation; stock	
963	do	do	K-1	1890	do	117	105	?80	53	70	Wind			Domestic; stock	
964	do	San Joaquin	M-7	1891	Bored, 6-inch	168	156	200	60		Wind, horse-power.			do	
965	do	Santa Ana	F-7	1891	do	63	63	200			Artesian			Irrigation	3
966	do	do	F-7	1891	do	63		200	25		Hand				
967	do	Lomas De Santiago.	L-4	1891	Bored, 7-inch	100	100	300+	69	73	Artesian			Not used	Small.
968	do	do	M-2	1894	Bored, 8-inch	138	117	719	43		Steam			Irrigation	†15
970	do	San Joaquin	H-6	1897	Hydraulic, 2-inch	55	55	125	22		Artesian			Domestic	4
971	J. Morris	Lomas De Santiago.	M-2	1897	Bored, 6-inch	150	120	?100	115		Wind			Domestic; stock	
972	Irvine Rancho Co	do	M-6	1897	Bored, 7-inch	160	107	163	69		do			do	
974	do	San Joaquin	K-6	1897	Dug, 4 by 4 foot	80	68	14	79		do			do	
975	S. T. Rutherford	do	K-5	1897	Dug, 3½ by 3½ foot	80	76	16			do			do	
976	Mr. Warne	Santa Ana	G-5	1897	Hydraulic, 2-inch	48	48	158	35	71	Artesian			Not used	Small.
977	Irvine Rancho Co	San Joaquin	L-3	1898	do	75	75	400	53	71	do	240.00		Stock	5
978	do	do	K-4	1898	do	65	65	362	72		do	240.00		do	Small.
979	do	do	J-5	1898	do	55	55	288							4
981	do	do	I-7	1898	do	50	50	165	30	81	Artesian			Stock	9

Wells in the Santa Ana quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
982	Irvine Rancho Co	San Joaquin	I-4	1898	Hydraulic, 2-inch	43	43	204	46	71	Artesian			Stock	7
983	do	do	J-4	1898	do	45	45	138	46	71	do			do	6
984	do	do	J-3	1899	do	48	48	150	49	72	do			do	5
988	do	do	H-6	1899	Hydraulic, 3-inch	60	60	210	37	71	do			do	3
989	do	do	H-6	1899	Hydraulic, 2-inch	55	55	140	25	75	do			Domestic; stock	6
990	do	Santa Ana	I-3	1899	Hydraulic, 4-inch	72	72	351	43		do			Irrigation	†25
991	do	do	J-3	1899	do	65	65	183			do			do	
993	do	San Joaquin	N-6	1899	Hydraulic, 4-inch, 155 feet; hydraulic, 2-inch, 141 feet.	200		296	69		Wind			Domestic	
1002	do	do	H-7	1899	Hydraulic, 3-inch	60		397	34	79	Flows into reservoir.			Stock	Small.
1003	do	Santa Ana	K-1	1900	Hydraulic, 2-inch	103		208	42		Not raised			Not used	
1006	do	San Joaquin	L-2	1900	do	75	75	189	42		Artesian			Stock	
1011	do	do	J-6	1900	do	25	25	163	52	72	do			do	
1012	do	do	I-6	1900	Hydraulic, 3-inch	35	35	70			do			Irrigation	19
1015	do	do	I-6		do	28	28	88	28	77	do			do	2
1016	do	do	H-7		Hydraulic, 2-inch	40	40	226	31	70	do			Artificial pond	
1020	do	do	H-7		do	40	40	112	32	77	do			Domestic	2
1024	do	do	J-6	1900	Hydraulic, 3-inch	25	25	122	66	72	do				10
1027	do	do	J-6	1900	Hydraulic, 2-inch	25	25	51	57	72	do			Stock	4
1028	do	do	I-6	1900	Hydraulic, 3-inch	55	55	80			do				†12

		ago.													
1039	.....do	San Joaquin	I-6	1900	Bored, 7-inch	35	35	298	31	70	Artesian			Irrigation	
1040	.....do	.....do	I-6	1900	.....do	35	35	91	26	77	.....do			.....do	
1046	.....do	Santa Ana	J-3	1901	Bored, 10-inch	65	65	193	40	69	.....do			.....do	†18
1047	.....do	Lomas De Santiago.	L-1	1901	Bored, 12-inch	145		164	49	75	Gas			.....do	32
1040	.....do	San Joaquin	L-2	1901	Bored, 10-inch	75	73	252	45		Wind			Domestic; stock	
1051	.....do	Lomas De Santiago.	N-4, 5	1903	Hydraulic, 4-inch	220	100	246	141		.....do	$117.50	$60.00	.....do	
1054	.....do	.....do	N-4	1903	.....do	115		200				30.00			
1056	.....do	.....do	N-4	1903	.....do	215	135	271	90		Wind	96.25	60.00	Domestic	
1058	.....do	.....do	N-3	1903	.....do	120		321			.....do	49.50		.....do	
1062	.....do	.....do	L-2	1903	Bored, 15-inch	130	102	400				925.33			
1064	.....do	San Joaquin	N-6	1903	Hydraulic, 3-inch, inside of 4-inch.	200	126	368				85.00			
1066	.....do	.....do	M-6	1903	Hydraulic, 4-inch	140		75				22.00			
1069	.....do	.....do	L-6		.....do	135	70	114				45.00			
1071	.....do	Santa Ana	F-7	1904	.....do	65		210				33.00			
1073	.....do	.....do	G-6	1904	Hydraulic, 3-inch	50	50	152	22	75	Artesian	44.00		Stock	9
1075	.....do	.....do	!-4	1904	Hydraulic, 4-inch	52	52	394	44	68	.....do			Irrigation	
1077	.....do	.....do	I-3	1904	.....do	55	55	415	42	72	.....do			Not used	
1084	W. H. Best	.....do	K-1	1900	Bored, 10-inch	110	100	?375	44		Hand				
1085	W. L. G. Haskins	.....do	K-1	1893	Bored, 7-inch	110	98	51	56		.....do	51.00		Domestic; stock	
1086	Hayrod Bros	Lomas De Santiago.	M-1	1902	Dug, 4 by 4 foot	275	252	30			.....do			Stock	
1087	Wm. Jeffrey	San Joaquin	L-5	?1894	Dug, 3½ by 3½ foot	90	75	16	83	68	Wind			Domestic; stock	
1088	W. D. Bowman	Santa Ana	L-1	1904	Bored, 7-inch	95		58	49		Hand	60.00	16.00	.....do	
1089	Cubben & McFadden.	Lomas De Santiago.	M-5	1903	.....do	140	100	100+	78	73	Gas			Domestic; irrigation; stock.	†27
1090	Fred Page	San Joaquin	L-6	1901	Dug, 2 by 4 foot	98	71	28	91	65	Wind			Domestic	
1092	C. S. Hubbard	Santa Ana	K-2	1892	Bored, 6-inch	75	65	?26	57		Hand			Domestic; stock	
1093	.....do	.....do	K-2	1890	.....do	80	68	?50	61	68	Hand; wind			.....do	
1095	B. E. Buck	.....do	K-1	?1893		115			54	65	Hand			Domestic	
1096	C. C. Lambert	.....do	K-1	1892	Bored, 8-inch	115	80	?70	53		Wind			.....do	
1097	Mr. Cullom	.....do	K-1		Bored, 7-inch	115	89	34	55		Hand			Domestic; stock	

Wells in the Santa Ana quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
1098	E. E. Cook	Santa Ana	K-1		Bored, 7-inch	115	93	25	56		Wind			Domestic; stock	
1099	M. W. Johnson	do	K-2	1894	do	100		118	56		do			Domestic	
1101	Mr. Higgins	do	K-2		Bored, 6-inch	95			57	68	do			Domestic; stock	
1102	Thos. Rawling	do	K-1		Bored, 7-inch	100			183		Hand			Domestic	
1103	Wm. McGreevy	do	I-1		Bored, 6-inch	103	66	42	62		Wind			do	
1104	Wm. Halesworth	do	I-1		do	103		?55	65		do			do	
1106	G. R. Smith	do	I-1		Bored, 7-inch	135	97	46	73	67	do			do	
1107	M. P. Mathews	do	I-1		do	140		52	55		do			do	
1108	H. C. Babcock	do	I-1	1904	Dug, 4-foot diameter.	148	95	54	95		Hand			do	
1109	Mrs. S. W. Baker	do	I-1	1899	Bored, 7-inch	133		49	66						
1110	J. E. Taylor	do	I-1	1900	do	133	96	48	73	65	Wind, electric motor.			Domestic	
1111	J. B. Joplin	do	I-1	1888	do	133		46	70	67	Wind			do	
1112	H. W. Lewis	do	J-1	1901	do	135			52		do	$100.00		do	
1114	H. A. Allen	do	J-1	?1883	Bored, 6-inch	130		?160	65		do			do	
1115	Mrs. Hilton	do	J-1		Bored, 7-inch	130			71		do			do	
1116	L. Carrier	do	J-1	?1888	do	130	97	76	61		do			do	
1117	W. H. Comstock	do	J-1	?1894	do	125	94	62	68		do			do	
1118	J. Griset	do	J-1	1902	do	130		100+	63		Hand			do	
1120	A. G. Campbell estate	do	J-2	?1897	do	115		56	63		Wind			Domestic; stock	
1121	Mrs. S. P. Turner	do	J-1	1899	do	115	98	?110	59		do	111.00		Domestic	
1122	Mr. Wullingberger	do	J-2	1878	do	115	85	80	64		do			do	

1124	John Awe	do	J-1	1892	do	120		?80	52		do			do	
1125	J. W. Ballard	do	J-1		do	120			48		do			do	
1126	Geo. Preble	do	J-1			125		90			do			do	
1127	W. L. Adams	do	J-1	?1879	Bored, 6-inch	125	112	450			Not raised			Not used	
1128	Thompson Bros	do	J-3	1900	Bored, 7-inch	55	55	284	48	73	Artesian			Domestic; irrigation; stock.	
1129	do	do	J-3	1900	do	53	53	282	50	68	do			do	1
1131	Robert Boyd	do	I-4	1902	Hydraulic, 2½-inch.	45	45	108	40	68	do			do	5
1132	Irvine Rancho Co	San Joaquin	G-8	?1895	Bored, 7-inch	100	25	?150	161		Wind			Stock	
1133	W. W. McCarrell	Santa Ana	F-4	1903	Dug, 3½ by 3½ foot.	40	32	13	151	62	Hand			do	
1134	B. W. Ellis	do	F-4	1903	Hydraulic, 2-inch	40	40	?230	35	63	Artesian			Domestic; stock	3
1135	do	do	F-4	?1884	Bored, 4-inch	40	40	?190	39		do			Stock	
1136	do	do	F-4	?1884	do	38	38	?190	25	62	do			Irrigation	
1137	Fred Raibel	do	E-4		Hydraulic, 2-inch	35	35		30	63	do			Domestic	
1138	I. M. Von Schriltz	do	E-4	1902	Bored, 4-inch	35	35	200+	29	66	do			Stock	
1139	do	do	E-4	1908	Bored, 10-inch	35	35	?400	32	68	do			Irrigation	1
1140	do	do	E-4		Bored, 4-inch	35	35	141	30	65	do			do	1
1141	do	do	E-4		do	35	35	152	29	66	do			do	1
1142	Mrs. Mary Smith	do	E-4	?1874	Hydraulic, 3½-inch.	35	35	?312	38	65	do			Domestic; stock	Small.
1143	P. J. Matthews	do	E-4		Bored, 4-inch	35	35		30	65	Artesian, hand			do	
1144	Mr. Davis	do	E-4		Bored, 6-inch	35	35		34	67	Artesian			Domestic; irrigation; stock.	
1145	J. W. De Witt	do	F-4		Bored, 3½-inch	42	42	185	32	66	do			do	
1146	do	do	F-4	1889	Bored, 4-inch	40	40	?225	36	65	do			Irrigation; stock	
1148	R. W. McClain	do	F-4			42			34		do				
1149	do	do	F-4		Bored, 4-inch	42	42	375	32		Not raised			Not used	
1150	W. H. Kedford	do	F-4	?1874	Bored, 3½-inch	45	45		37		Artesian			Domestic; stock	
1151	Newport school district.	do	F-4		Hydraulic, 2-inch	43	43		37		do			Domestic	
1152	W. F. Cullen	do	F-4	1874	Bored 4-inch	43	43	160	37		do			Domestic; irrigation; stock.	
1153	E. S. Wakeham	do	F-4	?1884	Hydraulic, 2-inch	43	43	310	30	71	do			do	
1154	do	do	F-4	?1874	Bored, 7-inch	43	43	?160	68	69	do			Stock	

Wells in the Santa Ana quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
1155	M. H. Bear	Santa Ana	G-4	1894	Hydraulic, 2-inch	40	40	125	39	....	Artesian			Domestic; irrigation; stock.	
1156	Thos. Armstrong	do	G-4	?1880	Bored, 4-inch	40	40	?180	38	....	do			do	
1157	do	do	F-4		do	45	45	?90	30	67	do			Stock	
1158	J. G. Lynch	do	G-4	1884		40	40	195	37	69	do			Irrigation	
1159	G. W. Ford	do	G-4	1884	Bored, 4-inch	40	40	210	39	....	do			do	11
1160	L. Wakeham	do	G-5		Hydraulic, 4-inch	40	40	320	32	72	do			Domestic; irrigation.	11
1161	T. J. Mitchell	do	G-5	?1885	Dug, 3½ by 3½ foot.	40	36	8	32	62	Hand			Stock	
1163	J. E. Garner	do	G-4		Bored, 4-inch	40		30	40		do			Domestic	
1164	do	do	G-4		do	40		60	39		do			Stock	
1165	F. D. Leonard	do	G-4		do	40			43		do			Domestic; stock	
1166	Wm. Gracer	do	F-4	1901	Hydraulic, 2-inch	42	42	325	29		Artesian	$225.00		do	Small.
1167	do	do	F-4	?1884	Bored, 7-inch	40	40		35		do			Irrigation	9
1168	Mr. Stanley	do	E-4			40	40		37		do				
1169	L. A. Mann	do	E-4	1902	Bored, 3-inch	35	35	326	33	69	do			Domestic; irrigation; stock.	†11
1170	Sherman Babb	do	E-4	1900	Bored, 4-inch	35	35	326	29		do	300.00		Irrigation; stock	
1171	Wm. Gracer	do	E-4	1884	do	32		?100	32	68	Hand			Domestic; stock	
1172	Edwin Snow	do	E-4	1886	Bored, 6-inch	30	30	300+	28	71	Artesian			Domestic; irrigation.	†60
1173	O. B. Streeter	do	F-4		Bored, 4 inch	45	45		40		do			Domestic; stock	
1174	A. T. Cole	do	F-4	1894	Hydraulic, 2-inch	40	40	?108	35	67	do			do	
1175	do	do	F-4	?1880	Bored, 4 inch	40	40	140	41	67	do			Irrigation	

					Bored, 7-inch	40	40		37	67	do			Domestic; irrigation; stock.	Small.
1178	J. T. Harris	do	F-5		Bored, 4-inch	47	47	108	30		do			Domestic; irrigation.	
1179	H. A. Bingham	do	F-5		Bored, 3-inch	50	50	200+	33		do			Domestic; irrigation; stock.	Small.
1180	do	do	F-5		Hydraulic, 2-inch	55	55		36	68	do			Domestic	
1181	J. C. Hopkins	do	F-5	?1886	Bored, 4-inch	50	50	?180	29	72	do			Domestic; irrigation; stock.	17
1182	F. D. Leonard	do	F-6	?1875	Bored, 7-inch	72	72	316	25	78	do			Irrigation	11
1183	do	do	F-5	1902	do	45	45	170	32	67	do			Domestic; stock	
1184	Fairview Colony	do	F-5	?1886	Bored, 4-inch	50	50	154	26	73	do			Domestic; irrigation.	5
1185	do	do	G-5	?1875	Bored, 3-inch	45		70			Not raised			Not used	
1186	J. Speed	do	G-5	1898	Hydraulic, 3-inch	45	45		33	71	Artesian			Domestic; irrigation; stock.	
1187	Fred Chatterton	do	G-5	1898	Bored, 4-inch	45	45	182	31	69	do	100.00		do	
1188	do	do	G-5	1886	do	45	37	200			Not raised			Not used	
1189	Fairview Colony	do	G-5	?1875	do	45	45	105			do			do	
1190	T. J. Mitchell	do	G-5	?1886	do	40	40	180			Artesian			Stock	
1191	do	do	G-5	1886	Bored, 7-inch	40	40	?180			do			do	
1192	M. A. Baker	do	G-5	?1894	Bored, 4-inch	45	43	?180	31	67	Not raised			Not used	
1194	Fairview Colony	do	G-5	?1880	Hydraulic, 3-inch	45	45	?175	33		Artesian			Irrigation; stock.	
1195	J. L. Goodwin	do	G-5	1898	Bored, 3-inch	45	45	228	26	72	do			Domestic	
1196	O. B. Hallock	do	F-5	?1899	Hydraulic, 3-inch	45	45	160	33		do	80.00		Domestic; stock	
1197	do	do	G-5	1902	do	45	45	220	26	72	do	110.00		Irrigation	Small.
1198	A. A. Holden	do	F-5		Bored, 4-inch	45	45		31	72	do			Domestic; irrigation; stock.	5
1200	Mr. Lurvey	do	G-5	1901	Hydraulic, 2-inch	45	45	333	21	70	do			Domestic; irrigation.	Small.
1201	Mr. Einhoff	do	D-8	1902	Bored, 7-inch	98	68	675			Not raised			Not used	
1202	C. T. Platt	do	F-5	1904	Bored, 12-inch	48	48	294	36	71	Artesian			Irrigation	
1203	G. Leibermann	do	G-5	1902	Hydraulic, 2-inch	45	45	360	33	69	do	120.00		Domestic; irrigation; stock.	
1204	Mr. Stevens	do	G-5		Bored, 4-inch	45	45	178	27	73	do			do	4
1205	M. A. Baker	do	G-5		do	48	48	120	32	73	do			do	1
1206	Irvine Rancho Co	do	G-6		Dug, 3 by 3 foot	48			81		Hand			Domestic; stock	

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						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
1207	G. Leibermann	Santa Ana	G-5	1886	Bored, 3-inch	45	45	?180	33		Artesian			Irrigation; stock.	
1208	C. M. McClintock	do	F-5	?1870	Bored, 7-inch	40	40		38	67	do			Domestic; irrigation; stock.	
1209	do	do	F-5	?1880	Bored, 4-inch	40	40	125			do			Stock	
1210	J. H. Meyer	do	E-6	?1886	Bored, 7-inch	72	72	360	33		do			Domestic; stock	
1211	H. D. Meyer	do	D-6	1897	Dug, 4 by 4 foot	25	20	14	96		Wind			Domestic; irrigation; stock.	
1212	W. L. Adams	do	D-6	1904	Bored, 7-inch	25	19	528	96	72	Not raised			Not used	
1213	do	do	D-6	1879		25	19	400	98		Wind				
1214	Mr. Powell	Las Bolsas	D-5		Hydraulic, 2-inch	25	25	?100	31	66	Artesian			Stock	
1215	W. S. Brunton	do	C-5	?1899	Hydraulic, 1½-inch.	25	25	90	31	66	do			Domestic; stock	Small.
1218	Wm. Lamb	do	C-5	1895	Hydraulic, 2-inch	33	33	118	29	65	do			Irrigation; stock.	
1219	do	do	C-5		do	33	33	98	31	66	do			Stock	
1220	do	do	C-5		do	32	32	108	28	66	do			do	
1221	do	do	C-5		do	33	33	108	30	64	do			do	
1222	A. T. Swift	do	B-5	1904	Bored, 7-inch	35	35	130	27	65	do	$160.00		Domestic; irrigation; stock.	19
1223	do	do	B-5	1904	do	36	36	134	29	65	do	160.00		Irrigation	19
1224	do	do	B-5	?1897	Hydraulic, 2-inch	35	35	?60	27	66	do			Stock	
1225	I. M. Von Schrilts	do	E-4		Bored, 4-inch	32	32	65	36	66	do			do	
1226	do	do	D-4	1904	Bored, 6-inch	32	32	112	33	64	do			Irrigation; stock.	6
1227	Wm. Lamb	do	B-5	1890	Bored, 4-inch	34	34	108	29	66	do			Stock	
1228	do	do	B-5		Bored, 3-inch	34	34		30		do			Domestic	

1231	do	do	B-5	1904	Bored, 3-inch	33	33	88	30		do			do	19
1232	do	do	B-5	?1900	Bored, 2-inch	32	32	89	27	65	do			Domestic; stock	
1233	do	do	B-6	?1899	do	30	30	108			do			Not used	
1234	do	do	B-6		Bored, 3-inch	27	27	128			do			Stock	
1235	do	do	C-6		Hydraulic, 2-inch	27	27	87	27		do			do	
1236	do	do	C-5	1899	do	32	32	80			do			Not used	
1237	do	do	C-5		do	31	31	80	26	67	do			Irrigation	
1238	do	do	C-6		do	34	34	?80	27	65	do			do	6
1239	do	do	C-6		do	34	34	80			do			do	
1240	do	do	C-5	1885	do	28	28	114	30	65	do			Stock	
1241	do	do	C-5	1885	Bored, 2-inch	27	27		27		do			Irrigation; stock	8
1242	H. S. Worthy	do	B-5	1899	Bored, 4-inch, inside of 7 inch.	36	36		29	64	do			Domestic; irrigation.	
1243	A. L. Whitesides	do	B-5	1904	Bored, 7-inch	40	40	123	28	63	do	127.00		do	12
1244	C. E. and E. Griset	do	A-5	1903	Bored, 6-inch	60	60	104	29	66	Gas	75.00	$1,000.00	Irrigation	†20
1245	Mrs. Belle Martin	do	A-4			60			29		Wind			Domestic	
1246	T. A. Wells	do	B-4	1904	Bored, 7-inch	60	60	174	31	65	Gas, artesian		375.00	Domestic; irrigation; stock.	†23
1247	W. E. Wells	do	B-4	1901	Hydraulic, 2-inch	60	60		27	65	Artesian			do	
1248	J. B. Raine & Son	do	A-4	1901	Bored, 7-inch	75	42	83	30		Gas			Manufacturing	†40
1249	La Bolsa Tile Co.	do	A-4	1903	Bored, 6-inch	75	42	86	29		Steam	86.00		do	
1250	Huntington Beach Co.	do	A-5	1900	Bored, 10-inch	70	66	400			Gas	500.00	100.00	Irrigation	†35
1251	do	do	A-5	1897	Bored, 8-inch	70		870	43	74	do			do	†15
1252	do	do	A-6	1900	Bored, 10-inch	70	68	400			do	500.00		do	†35
1253	do	do	A-6	1898	Bored, 8-inch	70		135			do			do	†80
1254	do	do	A-5, 6	1898	Bored, 6-inch	70		75			Compressed air			do	†40
1255	do	do	A-6	1897	do	70		?250	24	68	Wind	250.00	150.00	Domestic	
1256	A. W. Brown	do	B-6	1898	Bored, 2-inch	24	24	95	25	67	Artesian			Stock	
1257	do	do	B-6	1901	Bored, 7-inch	25	25	?130	29		do			Irrigation	
1258	L. T. Wells	do	B-5	1903	Bored, 4-inch	32	32	?80	29	66	do			Domestic; stock	4
1259	do	do	B-5	1901	Hydraulic, 2-inch	32	32		29	64	do			Irrigation	
1260	do	do	B-6	1901	Bored, 3-inch	30	30	102	29	64	do			do	5
1262	A. L. Whitesides	do	B-5	1904	Hydraulic, 2-inch	35	35	?114			Artesian	65.00		do	†4
1264	do	do	B-5		Bored, 3-inch	35	35	101	28		do			do	11
1265	J. L. Worthy	do	B-5		Bored, 4-inch	32	32	100+	28	65	do			do	

Wells in the Santa Ana quadrangle—Continued.

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						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
1268	J. B. Bushard	Las Bolsas	B-6	1901	Bored, 3-inch	24	24	80	27	66	Artesian			Domestic; irrigation.	†16
1269	do	do	B-6	1899	Hydraulic, 2-inch	25	25	80	27	66	do			Irrigation	4
1270	do	do	B-6	1899	do	21	21	87	28	64	do			do	†9
1272	do	do	B-6	1900	Bored, 3-inch	24	24	80	27	64	do			Stock	
1273	do	do	B-6	1898	Bored, 7-inch	22	22	90	27	65	do			Irrigation	2
1274	J. C. Farnsworth	do	B-6	1898	do	20	20	100	27	65	do			Not used	
1276	Caspar Borchard	do	C-6	1898	Hydraulic, 2-inch	23	23	85	28		do			Irrigation	3
1277	do	do	C-6	1904	Bored, 3-inch	20	20	85	27	67	do			do	9
1278	do	do	C-6	1904	do	20	20	85	26	67	do	$65.00		do	9
1279	do	do	C-6	1900	Hydraulic, 2-inch	19	19		29	68	do			do	4
1280	do	do	C-6	1904	Bored, 3-inch	23	23	85	27	66	do			Domestic; irrigation; stock.	†12
1281	John Borchard	do	A-7		Bored, 4-inch	35	1	?34	25		Wind			Domestic; stock	
1282	Lydia A. Timmons	do	A-7		Bored, 7-inch	50	7	81	25		do	35.00		do	
1283	J. M. Hearn	do	A-7	1902	do	50		117	26		do	50.00		do	
1284	David Brush	do	A-6	1901	do	35	7	520	28		do	1,000.00	$200.00	do	
1285	N. Cary	do	A-6	1902	Hydraulic, 2-inch	35		?70	25		do	30.00		do	
1286	O. Uttersport	do	A-6		Bored, 7-inch	38	15	133	25		do			do	
1287	A. W. Brown	do	A-6	1903	do	50		84	66		do			do	
1288	W. T. Newland	do	A-6	1902	Bored, 4-inch	50	27	79	26		do	50.00	65.00	do	
1289	O. Uttersport	do	A-6	1901	Hydraulic, 2-inch	25	25	55	30		Artesian	50.00		Stock	
1289a	do	do	A-6	1901	Hydraulic, 3-inch	25	25	55	30		do			do	

1291	O. Utterssport	do	A-6		Bored, 2-inch	23	23	70	27		do	50.00			6
1292	W. T. Newlands	do	B-6	1900	Bored, 4-inch	23	23	108	27		do	27.00		Not used	†33
1293	do	do	B-6	1900	Bored, 3-inch	23	23	106	24		do			Irrigation	18
1294	Caspar Borchard	do	C-5	1898	Hydraulic, 2-inch	26	26	85	25	72	do			Domestic; irrigation; stock.	4
1295	do	do	C-5	1904	Bored, 3-inch	25	25	85		70	do			Irrigation	12
1296	do	do	C-5	1904	do	25	25	85	25	70	do			do	12
1297	do	do	C-5	1904	Hydraulic, 3-inch	25	25		25		do			do	18
1298	do	do	C-5	1904	do	24	24	85	25		do			do	28
1299	do	do	C-5, 6	1900	Hydraulic, 2-inch	24	24				do			do	4
1300	do	do	C-5	1900	do	24	24	85	26		do			do	6
1301	W. T. Newlands	do	B-6	1900	do	24	24	101	25		do			do	10
1302	Caspar Borchard	do	B, C-6	1900	do	20	20	85	25		do			Domestic	
1303	J. C. Farnsworth	do	B-6	1904	Hydraulic, 3-inch	20	20	92	27		do			Domestic; irrigation; stock.	11
1304	J. C. Townsend	do	B-7		Bored, 4-inch	18	18	93	27		do			Irrigation	†28
1305	J. M. Broad	do	B-7		do	18	18	137	27		do			do	1
1306	do	do	B-7			18	18		26		do			do	
1307	Mr. Woods	do	C-7		Hydraulic, 2-inch	14	14	81	25	66	do			Not used	
1308	N. J. Sanders	do	C-7		Bored, 4-inch	13	13		26		do				
1309	J. W. Sowles	do	C-6		Hydraulic, 2-inch	17	17	86	124		do				
1310	do	do	C-6	1899		18	18	?75	25		do			Domestic; stock	
1312	do	do	C-6		Hydraulic, 2-inch	19	19	91	29		do			Irrigation	3
1314	Henry Hockmeyer	do	C-7	1899	Hydraulic, 3-inch	10	10	87	26		do			do	5
1315	Mr. Meyers	do	C-7		Hydraulic, 2-inch	23	23	51	107	63	Siphon			Domestic; stock	
1316	Banning Bros	do	C-8		Dug, 2 by 3 foot	24	22	5	117		Wind			do	
1317	Mr. Snow	Santa Ana	D-5		Bored, 6-inch	55	55		22		Artesian			Domestic; irrigation; stock.	
1318	Henry Hockmeyer	Las Bolsas	B-7	1901	Hydraulic, 2-inch	12	12	111	25		do	42.00		do	†4
1319	do	do	B-7	1899	Bored, 7-inch	13	13	126	26		do	126.00		Stock	19
1320	do	do	B-7		Hydraulic, 2-inch	12	12	98	25		do	47.00		Irrigation	4
1321	do	do	B-7	1901	do	9	9	?106	29		do	38.00		do	
1323	Pacific Gun Club	do	C-8		Hydraulic, 3-inch	8	8	83	93	67	do			Stock	
1324	do	do	C-8		Hydraulic, 2-inch	5	5	98	155		do			do	
1326	do	do	C-8	1902	Bored, 4-inch	2	17–	100	66					Artificial pond	

Wells in the Santa Ana quadrangle—Continued.

Number of well.	Owner.	Location.	Map location.	Year completed.	Class of well.	Elevation of surface.	Elevation of water.	Depth of well.	Solids per 100,000.	Temperature of water.	Method of lift.	Cost of well.	Cost of machinery.	Use of water.	Quantity of water.
						Feet.	*Feet.*	*Feet.*		°*F.*					*Miner's inches.*
1327	Mr. Meyers	Las Bolsas	C-7		Hydraulic, 2-inch	9	9	?90	29		Artesian	$32.00		Domestic; stock	
1328	John Borchard	do	B-7	?1899	do	15	15	100+	28	64	do			do	
1329	do	do	B-7	?1899	do	13	13	100+	28	63	do			Domestic	
1330	W. T. Newlands	do	B-7		Bored, 4-inch	17	17	?130	30	66	do			Irrigation	
1331	J. S. Rice	Santa Ana	D-5		do	40	40	192	26	71	do			Domestic; irrigation; stock.	
1332	do	do	D-5		Bored, 7-inch	50	50		23	72	do			Irrigation; stock	
1333	R. J. Webster	Las Bolsas	D-5	1904	Bored, 4-inch	27	27	75	35	65	do			do	4
1335	J. E. Snow	Santa Ana	D-5		Hydraulic, 3-inch	50	50	182	23	72	do			do	4
1336	do	do	D-5		Bored, 3-inch, inside of 6-inch.	50	50	218	24	70	do			Stock; irrigation.	3
1337	do	do	D-5	1903	Bored, 4-inch	50	50	?230	22		do			Domestic; stock	4
1338	do	do	E-5		Hydraulic, 3-inch	50	50	157	28		do			Irrigation; stock	2
1339	W. S. Brunton	do	E-5	?1899	Bored, 3-inch, inside of 7-inch.	50	50	?200	26	73	do			Domestic	†2
1340	Clark Bros. & Babb	do	E-5	1886	Bored, 4-inch	50	50	?250	30		Wind			Domestic; stock	
1341	George H. Clark	do	E-5	?1901	Hydraulic, 3-inch	47	47	180	29		Artesian			do	Small.
1342	do	do	E-5	1904	Bored, 12-inch	42	42	375+			do			Irrigation.	
1343	do	do	E-5	1886	Bored, 7-inch	51	33	265	30		Wind			Stock	
1344	L. Montgomery	do	E-5	1886	Bored, 4-inch	52	52	280	25		Artesian			Domestic; irrigation; stock.	†45
1345	Geo. W. Griffiths	do	E-5	1892	Bored, 6-inch	52		320	31		Wind			do	
1346	Clark Bros. & Jefferson.	do	E-6		Bored, 4-inch, inside of 7-inch.	74		375+			Not raised	300.00		Not used	

1348	Irvine Rancho Co	do	F-8		do	85			156		do			do	
1349	Newport Beach Co	do	D-10	1901	Dug, 12 by 12 foot.	2	4–	8	105		Gas	50.00	$450.00	Sewers	
1350	do	do	D-10		Dug, 4 by 6 foot	2	1–	4			Wind			Domestic	
1351	"Boy" Club	do	F-10		Dug, 3 by 4 foot	6	1	7			do			do	
1352	do	do	F-10		Dug, 4 by 4 foot	2	2–	6		68	Hand			Stock	
1354	Newport Beach Co	do	D-10		Bored, 4-inch	2	2	500+			Hand valve			Not used	
1355	do	do	D-10		Dug, 3-foot diameter.	2	0	4		67	Wind			Domestic	
1356	M. A. Baker	do	G-5	1904	Hydraulic, 3-inch	48	48		29	72	Artesian			do	8
1358	L. M. Brooks	San Joaquin	M-15	1904	Dug, 4 by 4 foot	75	43	33		62	Hand			Stock	
1359	F. C. Frefren	do	M-15	?1898	Bored, 7-inch	75	10–	97			Wind			do	
1360	L. M. Brooks	do	L-15	1904	Dug, 4 by 4 foot	35	29	12			Hand			do	
1361	J. D. Ponder	do	M-15	1903	do	35	27	12		66	Wind			do	
1362	G. A. Burton	do	M-15		Dug, 3 by 3 foot	55	45	16		65	Hand			do	
1363	Joe Yoch	do	M-15		Bored, 7-inch	50	39	109			Wind			do	
1364	do	do	M-15		Dug, 4 by 4 foot	35	24	18			do			do	
1365	O. Warling	do	M-14		do	50	44	12			do			do	
1366	Mr. Clark	do	M-14		Dug, 8 by 8 foot	75	66	14			do			do	
1369	Mrs. Brown	do	N-12		Dug, 3½ by 3½ foot.	225	213	15	174		Hand			Domestic; stock	
1370	Fred Farmer	do	N-12		Dug, 4 by 4 foot	232	231	8	187		Gas			Irrigation	
1371	do	do	N-12		Bored, 7-inch	235	231	22	112	67	Hand			Domestic	
1372	Chas. Rauth	do	N-11		Dug, 4 by 4 foot	350	347	10	52		Wind			Domestic; stock	

INDEX.

Page.

Anaheim, average rainfall at 24-25, 29
average rainfall at, departures from, figure showing 28
rainfall at, table of 25
water level near, variation in, figure showing 24
Anaheim canal, views on 14
Anaheim quadrangle, area and location of. 10
artesian areas in 24
diminution of 24
maps of ..... Pocket.
wells in, data concerning 36-90
Anaheim Union Water Co., system of..... 14-16
Anaheim Water Co., history of..... 14-15
Artesian areas, diminution of 24
extent of 10
in Anaheim and Santa Ana quadrangles, location of, maps showing ..... Pocket.
location of 10
maps showing ..... Pocket.
theory of 21
Bedrock Canyon, water division at 14
Bolsa drainage district, organization of.... 20
Cajon Irrigation Company, history of..... 14-15
California Domestic Water Co., system of.. 14
Canals in Anaheim and Santa Ana quadrangles, maps showing ..... Pocket.
Cañon de Santa Ana Co., history of 14-15
Carpenter Water Co., history of 18-19
Casing, well, cost of 32
Chapman ditch, history of 16
Coastal plain area, location and character of 11
section of, figure showing 31
Collins, ——, acknowledgments to 35
Contours, hydrographic, in Anaheim and Santa Ana quadrangles, location of, map showing ..... Pocket.
in region, map showing ..... Pocket.
Crops, character of 11-12
irrigation, requirements of 11-12
Cunningham, E. C., acknowledgments to.. 35
Dam, submerged, data concerning..... 17-18
view of 16
Drainage districts, organization of 19-20
Drilling, cost of 32
East Whittier ditch, section of, figure showing 13
Electrolytic bridge, use of 34
Fisk, A. J., jr., work of 35

Page.

Furstenfeld, E. R., work of 35
Hall, W. H., on Anaheim Union Water Co... 14
on Santa Ana Valley Irrigation Co..... 16
Helwig, ——, acknowledgments to..... 35
Irrigation, progress of 9
rotation in 12
systems of 13-19
use of 11-12
Kramer ditch, history of 14-15
La Habra and East Whittier Water Co., system of 13-14
Lamb & Bourchard ditch, character of 20
Lands, irrigated, in Anaheim and Santa Ana quadrangles, area of 12
in Anaheim and Santa Ana quadrangles, maps showing ..... Pocket.
Los Angeles, irrigation near 9
wells near, investigation of 9
Los Angeles Vineyard Society, history of .. 14
McCarton, A. P., work of 35
Mansur, ——, acknowledgments to..... 35
Map showing location of irrigated lands, canals, drainage districts, and pumping stations ..... Pocket.
showing location of wells, artesian areas, and water levels..... Pocket.
Maps, description of 33-35
Miner's inch, equivalents of 12
Neff, J. B., water-level records by..... 25
Newlands ditch, character of 20
North Anaheim Canal Co., history of 14-15
Pumping plants in Anaheim and Santa Ana quadrangles, location of, maps showing ..... Pocket.
Quadrangle, definition of 10
Rainfall at Anaheim 24-25, 29
at San Bernardino..... 26
Rainfall, average, departures from, figures showing 27, 28
Rings, well, cost of 32
San Bernardino, average rainfall at, departures from, figure showing.. 27
rainfall at, table of 26
San Gabriel River, irrigation from..... 13
San Gabriel system, location and character of 13-14
Santa Ana canal, views on 16
Santa Ana quadrangle, area and location of. 10
artesian areas in, diminution of..... 24
drainage of 19-20
maps of ..... Pocket.

Page.
Santa Ana quadrangle, wells in, data concerning 91-137
Santa Ana River, irrigation from 13-14, 16
Santa Ana systems, location and character of 14-16
Santa Ana Valley Irrigation Co., system of. 14, 16-17
Santiago Canyon, submerged dam in, view of 16
Santiago Creek, irrigation from 13-14, 17-18
Santiago Land and Water Co., plant of 18
Semi-Tropic Land and Water Co., history of. 16
Serrano Water Co., history of 18
Sherwood, ——, acknowledgments to 35
Stearns Rancho Co., ditch of 20
Water, division of, method of 19
duty of 12, 23
Water, underground, character of 34
drains on 22-24, 29
investigation of 9-10
level of, map showing ..... Pocket.
variations in 24, 25, 29-30, 33
variations in, figure showing 24
overdevelopment of 29-30
permanence of 21-30
Water, underground, solids in, determination of ..... [illegible]
distribution of, map showing ..... [illegible]
source of ..... [illegible]
supply of ..... [illegible]
See also Contours, hydrographic.
Watson ditch, rights of ..... [illegible]
Wells, cost of ..... [illegible]
drafts on underground waters by ..... [illegible]
increase of ..... [illegible]
interdependence of ..... [illegible]
investigation of ..... [illegible]
in Anaheim quadrangle, data concerning ..... [illegible]
location of, map showing ..... Pocket.
in region, number of ..... [illegible]
in Santa Ana quadrangle, data concerning ..... 91-13[illegible]
location of, map showing ..... Pocket.
irrigation from ..... [illegible]
White, W. N., work of ..... [illegible]
Whittier, irrigation at ..... [illegible]
Willows ditch, construction of ..... [illegible]
Willows drainage district, organization of . [illegible]

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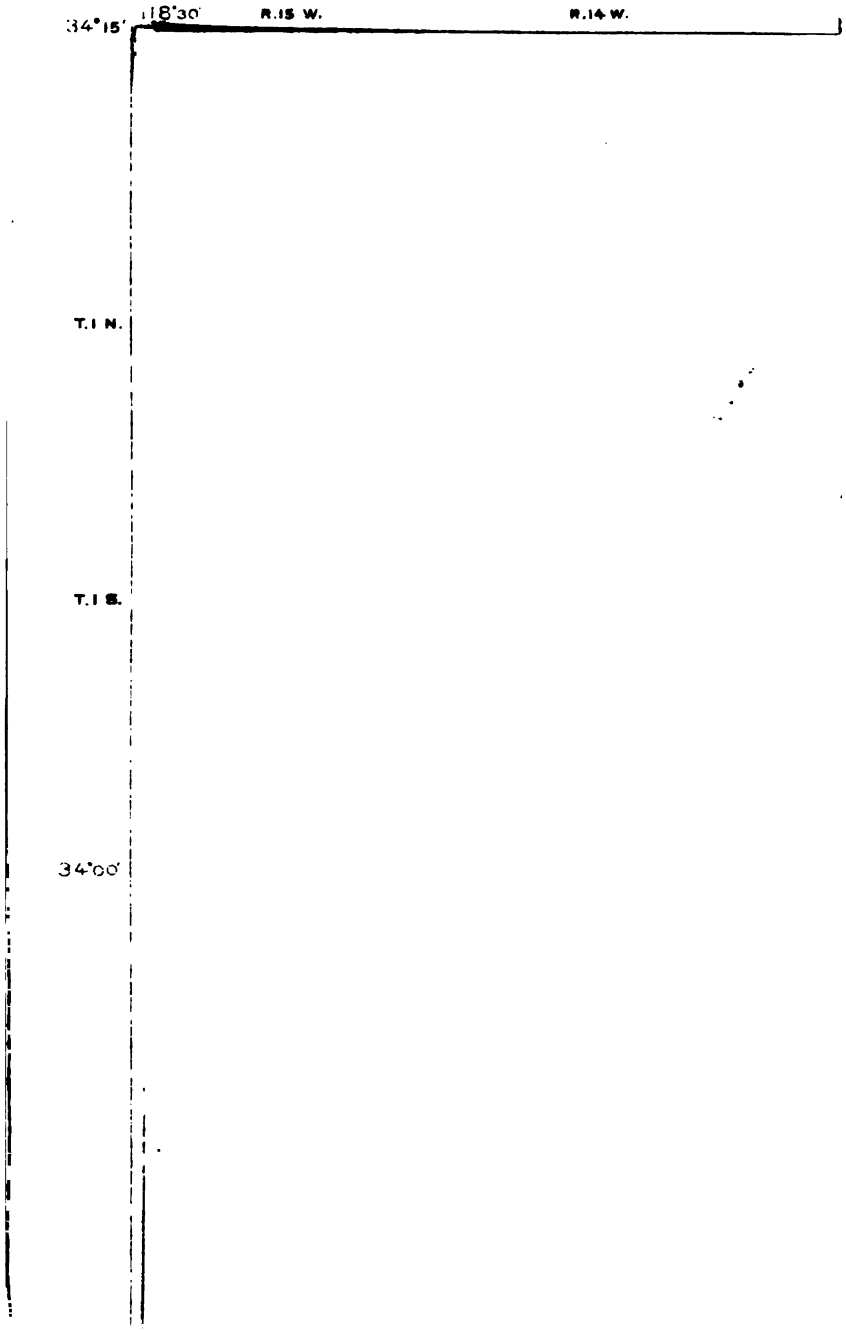

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